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The American Midland Naturalist

Devoted to Natural History, Primarily that of the Prairie States

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The American Midland Naturalist

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VOL. XIII. SEPTEMBER, 1932 No. 5.

PENNSYLVANIAN OSTRACODA

A Study of the Ostracoda Fauna of the East Mountain Shale, Mineral Wells Formation, Mineral Wells, Texas.

H. N. CORYELL AND CHARLES HURST SAMPLE

INTRODUCTION

A study of the microfossils of a formation has been recognized as one of the factors that tend to make more accurate the correlation of beds in subsurface and surface work. It is our purpose here to make available some of the most common species of the Ostracoda of the East Mountain Shale, member of the Mineral Wells formation to those who use the same fossils in making a detailed study of the Pennsylvanian of Texas.

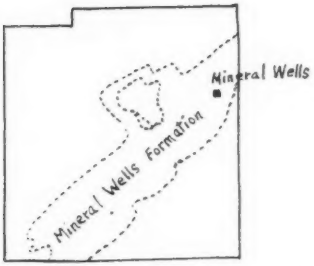
A classification chart shows the general position of the East Mountain Shale in reference to the accompanying formation, and an outline map gives the location from which the material was collected by the senior author with the aid of Mr. Norman Thomas of Fort Worth, Texas, to whom is extended sincere appreciation.

The East Mountain Shale consists of a dark gray shale well exposed in the escarpment near the eastern border of Mineral Wells, Texas. The lower contact has been described as marked by a massive sandstone and the uper limits contain limey fossiliferous lenses. The middle shale member in places reaches a thickness of nearly 300 feet. It is very fossiliferous both in macrofossils as well as in the smaller forms. The Ostracoda fauna shows some striking similarities to the Wetumka, Wewoka, Holdenville fauna from Oklahoma, described by Mr. Warthin. A number of the species were referred to forms collected from the Oklahoma formations.

CLASSIFICATION TABLE SHOWING THE POSITION OF THE EAST MOUNTAIN SHALE

- Pennsylvanian
  - Cisco
  - Canyon
  - Strawn
    - Mineral Wells
      - Keechi Creek ss. and sh.
      - Turkey Creek ss.
      - Salesville sh.
      - Lake Pinto ss.
      - *East Mountain Shale*
      - Brazos River ss.
      - Mingus sh.
      - Thurber coal.
    - Millsap
  - Bend.

OUTLINE MAP OF TEXAS SHOWING THE LOCATION OF PALO PINTO COUNTY.



OUTLINE MAP OF PALO PINTO COUNTY.

Showing the distribution of the Mineral Wells formation and the location of Mineral Wells near which the East Mountain Shale material was collected.

CLASSIFICATION AND DESCRIPTION

Phylum ARTHROPODA

Class CRUSTACEA

Order OSTRACODA Latrielle

Family LEPERDITELLIDAE Ulrich and Bassler, 1906

Leperditellidae Ulrich and Bassler, U. S. Nat. Mus., 1906, Bull. 30, p. 149
Aparchitidae Ulrich and Bassler, Md. Geol. Surv., 1923, Silurian, p. 296

Genus PARAPARCHITES Ulrich & Bassler, 1906

Paraparchites Ulrich and Bassler, Proc. U. S. Nat. Mus., 1906, Vol. 30, p. 149, pl. 11, figs. 1-4.

Paraparchites thomasi Coryell and Sample, n. sp.

Plate XXIV, Fig. 1

Carapace small and short, subtriangular in lateral view; hinge line straight, antero-cardinal angle slightly obtuse; anterior margin short, curved; posterior margin broadly rounded, with a moderate backward swing; greatest posterior extension very distinctly below mid-height; ventral margin convex, regularly rounded, sloping downward and backward from anterior; antero-dorsal spines large and long, pointing outward, upward and slightly toward the anterior; rising rather abruptly from the surface of the shell; greatest height near the middle of the posterior half.

Length, 0.37 mm.; height, 0.26 mm.

Holotype, Columbia University Paleo. Coll. No. 25271.

Locality; Mineral Wells shale pit, Mineral Wells, Texas.

This species differs from *Paraparchites cuneatus* Warthin in being a shorter form, with large dorsal spines and with the extension of the posterior margin distinctly lower.

Paraparchites thomasi was named in honor of Norman L. Thomas, Fort Worth, Texas, who assisted in collecting the material.

Paraparchites palopintoensis Coryell and Sample, n. sp.

Plate XXIV, Fig. 4

Carapace small, semicircular in lateral view; about 1.45

times as long as high; dorsal margin straight; hinge line long, straight; anterior broadly rounded greatest forward extension immediately anterior of dorsal spine; posterior broadly rounded; ventral margin rounded evenly into posterior and anterior margins; surface finely granulose, evenly convex; antero-dorsal spines of medium length, rising abruptly above dorsal margin, located about one-seventh the length of the shell back of the anterior margin; greatest height near center.

Length, 0.49 mm.; height, 0.33 mm.

Holotype, Columbia University Paleo. Coll. No. 25218.

Locality: Mineral Wells shale pit; three miles west of Mineral Wells, Texas.

Paraparchites brazoensis Coryell and Sample, n. sp.
Plate XXIV, Fig. 5

Carapace small, subovate; about 1.45 times as long as high; hinge line straight; anterior cardinal angle slightly obtuse; anterior margin broadly rounded, greatest forward extension only slightly above medium height; posterior margin broadly rounded with a backward swing; ventral margin evenly convex, joining anterior and posterior margins smoothly; surface finely granulose, evenly convex; antero-dorsal spines long, rising abruptly above dorsal margin about one-eighth the length of the shell back of the anterior; greatest height central.

Length, 0.49 mm.; height, 0.33 mm.

Holotype, Columbia University Paleo. Coll. No. 25219

Locality: Three miles west of Mineral Wells, Texas.

Paraparchites latidorsatus Warthin 1930
Plate XXIV, Fig. 2

Paraparchites latidorsatus Warthin, Okla. Geol. Surv., Bull. 53, 1930, p. 55, pl. IV, figs. 1a, b.

Carapace small, subovate; hinge line straight, present in anterior two-thirds of dorsal margin; antero-cardinal angle obtuse; anterior margin short, rounded; posterior margin rounded with a distinct backward swing; ventral margin well

rounded, sloping downward from anterior to posterior; surface finely granulose; antero-dorsal spines short; climax of convexity in antero-dorsal area; greatest height central.

Length, 0.46 mm.; heighth, 0.34 mm.

Locality: Mineral Wells shale pit; three miles west of Mineral Wells, Texas.

Paraparchites oblongus Coryell and Sample, n. sp.

Plate XXIV, Fig. 3

Carapace small, subovate in lateral view; about 1.5 times as long as high dorsal margin straight; hinge line straight, depressed; greatest extension only slightly below the dorsal margin; anterior margin short, rounded; posterior margin broadly rounded with a distinct backward swing; ventral margin convex, evenly rounded into posterior and anterior margins; surface finely granulose; greatest convexity in area of spines; antero-dorsal spines short, pointing forward and upward as a continuation of the overhanging dorsal margin; greatest height nearly central or slightly posterior to center.

Length, 0.56 mm.; height, 0.37 mm.

Holotype, Columbia University Paleo. Coll. No. 25220.

Locality: Three miles west of Mineral Wells, Texas.

Family BEYRICHIIDAE Jones

Genus HOLLINELLA Coryell, 1928

Hollinella Coryell, Journ. Paleo., 1928, vol. 2, p. 378, pl. 51, fig. 1.
Basslerina Moore, Dennison University, 1929, Bull. 29, No. 2, p. 103, (Jour. Sci. Lab., 1929, vol. 24, p. 103).
Hollinella Kellett, Jour. Paleo., 1929, vol. 3, no. 2, pp. 196-217.

Hollinella digitata Kellett 1929

Plate XXIV, Fig. 15

Beyrichia radiata Ulrich and Bassler, (not Jones & Kirkby), Proc. U. S. Nat. Mus., 1906, vol. XXX, No. 1446, p. 156, pl. XI, fig. 5.
Hollinella digitata Kellett, Jour. Paleo., 1929, vol. 3, no. 2, p. 209, pl. 26, figs. 1a, b.

Carapace small, elongate, subquadrangular in lateral view; equivalved; dorsal margin straight, ending anteriorly in a spine; anterior end gently rounded, cut back; posterior broad-

ly rounded with a backward swing; ventral gently convex; posterior and ventral margins determined by a relatively narnow flange which terminates near the anterior in a prominent spine; surface granulose and nodose; a sulcus located just posterior to the center and in dorsal half of the shell is marked by a small bulb on the posterior side and on the anterior side by a large, conspicuous bulb whose diameter is approximately one-fourth the length of the shell, and which goes to or slightly beyond the dorsal margin.

Length, 0.96 mm.; heighth, 0.55 mm.

Locality: Three miles west of Mineral Wells, Texas.

Hollinella bulbosa Coryell and Sample, n. sp.

Plate XXIV, Fig. 7

Carapace small, subquadrangular in lateral view; about 1.4 times as long as high; equivalved; dorsal margin straight, terminated anteriorly by a spine; anterior gently rounded, cut back as it nears ventral margin; posterior margin rounded with a backward swing; ventral margin convex; posterior-ventral and ventral margins determined by a frill which is convex posteriorly, but becomes concave in its anterior portion, extending well up on the anterior; surface coarsely granulose, convex; greatest convexity marked by the U-shaped swelling which is terminated posteriorly by a low, inconspicuous bulb about one-third the length of the shell from the posterior margin; the anterior termination of the U-shaped swelling is a large hemispherical bulb, located just anterior to middle of dorsal half of valve; bulbs separated by a well defined sulcus; greatest height median.

Length, 1.2 mm.; height, 0.79 mm.

Holotype, Columbia University Paleo. Coll. No. 25251.

Locality: Three miles west of Mineral Wells, Texas.

Hollinella harltoni Kellett 1929

Plate XXIV, Fig. 8

Hollinella harltoni Kellett, Jour. Paleo., 1929, vol. 3, no. 2, p. 211, pl. 26, figs. 10a, b.

Carapace small, subquadrangular in lateral view; length about 1.6 times the height; dorsal margin straight; anterior

gently curved, with backward swing; posterior gently rounded; ventral margin evenly convex; free margin characterized by a single row of small spines; surface finely granulose; a centrally located U-shaped convexity is terminated dorsally by two bulbs; posterior bulb only slightly prominent, about one-third of length of valve from posterior margin; anterior bulb hemispherical, prominent, located about one-third length of valve from anterior end and only a short distance from the dorsal margin; greatest height near the middle.

Length, 0.59 mm.; height, 0.37 mm.

Locality: Three miles west of Mineral Wells, Texas.

Genus **Hollites** Coryell and Sample, n. g.

Genotype *Hollites papillosus* Coryell and Sample, n. sp.

Small equivalved, slightly elongate, ostracode with a straight hinge line; the anterior margin narrowly rounded and truncated ventrally, emphasizing the backward swing appearance of the free border; the surface convexity is modified by the presence of a nearly centrally placed U-shaped swelling, that is prominent in the anterior portion and spreads out into the general convexity of the posterior half. A sinus is present within the "U" and extends from the dorsal margin nearly to the center of the valves, usually trending slightly towards the posterior ventral area; several prominent spinous tubercles are present, and irregularly distributed over the surface of the valve, being more closely spaced and in somewhat of an alignment, near the free margin.

The general outline of this specimen is somewhat like that of *Hollinella*, but the prominent bulbs are absent. The shape of the carapace and the character of the U-shaped swelling separates it from either *Bollia* or *Dilobella*. In surface ornamentation, general outline features it resembles *Beyrichia kloedeni tuberculata clausa* Jones and Holl, but does not possess the multilobate character.

Range — Pennsylvanian.

Hollites papillosus Coryell and Sample, n. sp.

Plate XXIV, Fig. 9

Carapace small, slightly elongate, length about 1.6 times

the height; dorsal margin straight; anterior margin short, curved; the greatest anterior extension about 1/3 of the distance of the greatest height; posterior margin broadly rounded with only a nominal backward swing; ventral margin evenly curved into the anterior and posterior margins; surface moderately convex, spinose; the U-shaped swelling is pronounced in anterior part, while posterior part of swelling grades into the general convexity of the posterior portion of the shell; arms of U-shaped swelling separated dorsally and in the middle by a distinct sulcus located near the center and in the dorsal half of the shell, sloping slightly toward the posterior; greatest height posterior; greatest width probably in ventral part of U-shaped swelling.

Length, 0.61 mm.; height, 0.38 mm.

Holotype, Columbia University Paleo. Coll. No. 25252.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Genus CORNIGELLA Warthin, 1930

Cornigella Warthin, Okla. Geol. Surv., 1930, Bull. no. 53, p. 59, pl. IV, figs. 7b, c.

Carapace minute, equivalved, subquadrate; greatest height in posterior half; greatest thickness central; hinge line straight, slightly less than the greatest length of the carapace; valves equal; surface granulose, reticulated in less prominent portions; the genotype has eight prominent spines on each valve, one of which extends well above the hinge line.

The type specimen is exfoliated and does not show the reticulations.

A study of *Beyrichia tuberculospinosa* Jones and Kirkby might show that it should belong to this genus.

Cornigella minuta Warthin 1930

Plate XXIV, Fig. 6

Cornigella minuta Warthin, Okla. Geol. Surv., 1930, Bull. no. 53, p. 59, pl. IV, figs. 7b, c.

Carapace minute, subquadrate in lateral view; equivalved; dorsal margin straight; anterior margin smoothly rounded;

posterior margin broadly rounded; ventral margin smoothly rounded; anterior cardinal angle obtuse; free margin marked by a narrow, inconspicuous flange; surface finely granulose, reticulated in the less prominent parts; eight knobs appear on the surface of the valve, the two largest located centrally near the dorsal margin, and the two smallest anteriorly and posteriorly near the dorsal margin; the largest knob is anterior to median portion of carapace; greatest height posterior.

Length, 0.41 mm.; height, 0.23 mm.

Locality: Three miles west of Mineral Wells, Texas.

Cornigella longispina Coryell and Sample, n. sp.

Plate XXIV, Fig. 12

Carapace small, subquadrate in lateral view; equivalved; dorsal margin straight; anterior margin slightly rounded; posterior margin rounded with a backward swing; ventral margin smoothly rounded; free margin marked by a narrow flange; ventral-posterior portion of margin finely spinose; surface finely granulose, reticulated except on knobs and on flange; six knobs appear at more or less regular intervals over the surface; the two largest knobs being located near the dorsal margin; largest knob is anterior of the middle conspicuous, extending above the dorsal margin; the cardinal angle spines are reduced to scarcely more than large granules; greatest height posterior.

Length, 0.41 mm.; height, 0.23 mm.

Holotype, Columbia University Paleo. Coll. No. 25253.

Locality: Three miles west of Mineral Wells, Texas.

Family KLOEDENELLIDAE Ulrich and Bassler, 1923

Genus JONESINA Ulrich and Bassler, 1908

Jonesina Ulrich and Bassler, Proc. U. S. Nat. Mus., 1908, vol. 35, p. 324

Jonesina acuneata Warthin, 1930

Plate XXIV, Fig. 10

Jonesina acuneata Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 61, pl. IV, figs. 9a, b.

Carapace small, elongate, subquadrangular in lateral view;

hinge line straight, short; anterior distinctly cut back below center of shell; posterior margin curved; ventral margin straight or slightly convex; surface finely granulose; sulci shallow, just posterior to middle of shell; overlap most conspicuous along the ventral border; greatest thickness anterior.

Length, 0.70 mm.; height, 0.36 mm.

Locality: Three miles west of Mineral Wells, Texas.

Jonesina ampla Warthin, 1930

Plate XXIV, Fig. 14

Jonesina ampla Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 61, pl. IV, figs. 8a, b.

Carapace small, subrhomboidal in lateral view; hinge line short, straight, anterior half concealed by inflation of the carapace; anterior cardinal angle obtuse; anterior margin gently rounded; posterior margin rounded with a distinct backward swing; ventral margin nearly straight; surface finely granulose; sulci just back of middle line of the shell, broad and shallow in upper part, more constricted toward lower end, greatest thickness located about one-third the length of the shell from the anterior end.

Length, 0.73 mm.; height, 0.43 mm.

Locality: Three miles west of Mineral Wells, Texas.

Jonesina texana Harlton, 1927

Plate XXIV, Fig. 13

Jonesina texana Harlton, Univ. of Texas, 1927, Bull. 2901, p. 146, pl. I, figs. 14a, b.

Carapace small, subrhomboidal in lateral view; hinge line straight; anterior margin slightly rounded until it abruptly curves into the ventral margin; posterior margin rounded with a distinct backward swing; ventral margin gently convex; anterior cardinal angle obtuse; surface very finely granulose; sulci in dorsal half, just anterior to middle, pointing slightly toward posterior, ending distinctly in the dorsal half of shell; greatest thickness just anterior to middle.

Length, 0.58 mm.; height, 0.35 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Genus KIRKBYINA Ulrich and Bassler, 1908

Kirkbyina Ulrich and Bassler, Proc. U. S. Nat. Mus., 1908, vol. 35, p. 322, pl. XLIII, figs. 11-14.

Kirkbyina laevis Warthin, 1930

Plate XXIV, Fig. 11

Kirkbyina laevis Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 62, pl. IV, figs. 12a, b.

Carapace small, subrhomboidal in lateral view; dorsal margin straight; anterior cardinal angle obtuse; anterior margin rounded, sloping posteriorly near the ventral margin; posterior margin rounded with a backward swing; ventral margin evenly convex; surface finely granulose; sulci broad and poorly defined, posterior to center in dorsal half of shell; greatest thickness near the center of the anterior half; overlap of right valve visible on free margin.

Length, 0.67 mm.; height, 0.38 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Family KIRKBYIDAE Ulrich and Bassler, 1906

Genus MOORITES Coryell and Billings, 1932

Moorites Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, no. 4, p. 182

Moorites minutus (Warthin), 1930

Plate XXIV, Fig. 18

Glyptopleurina ? minuta Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 67, pl. V, fig. 6a, b.

Moorites minutus Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, no. 4, p. 183, pl. XVIII, fig. 6.

Carapace small, subquadrate in lateral view, elongate; dorsal margin straight; anterior margin rounded, joining dorsal margin abruptly; posterior margin curved, backward swing pronounced; ventral margin convex on ends and concave in center; free margin defined by a scroll-like ridge; marginal ridge weak and poorly defined in central portion of ventral margin; surface gently convex, finely punctate, and marked by rows of pits; greatest height posterior; anterior height only slightly less than the posterior height.

Length, 0.42 mm.; height, 0.22 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Moorites hewetti Coryell and Billings, 1932

Plate XXIV, Fig. 17

Moorites hewetti Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, p. 182, pl. 18, fig. 5.

Carapace small, elongate; dorsal margin straight; anterior margin slightly curved, truncate, nearly vertical; posterior margin well rounded with a backward swing; ventral margin nearly straight, sloping upward anteriorly; free margin defined by a scroll-like ridge; surface finely punctate, convex, ornamented by rows of pits; greatest height posterior; anterior height as much as one-fourth less than posterior height.

Length, 0.35 mm.; height, 0.15 mm.

Holotype, Columbia University Paleo. Coll. No. 25243.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Moorites parallela Coryell and Sample, n. sp.

Plate XXIV, Fig. 16

Carapace small, subrectangular in lateral view, elongate; about 2.1 times as long as high; anterior margin regularly curved; posterior margin is narrowly rounded and extended with a backward swing; ventral margin straight, parallel to dorsal margin; free margin defined by a scroll-like ridge; surface slightly convex, granulose, ornamented by poorly defined pits.

Length, 0.33 mm.; height, 0.15 mm.

Holotype, Columbia University Paleo. Coll. No. 25255.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Genus MOOREA Jones and Kirkby, 1867

Moorea Jones and Kirkby, Quart. Jour. Geol. Soc. London, 1867, vol. 23, p. 494;
Jones & Holl, Ann. Mag. Nat. Hist., ser. 4, 1869, vol. 3, p. 325;
Jones & Kirkby, Proc. Geol. Assoc. London, 1886, vol. 9, p. 508;
Jones, Monthly Micros. Jour., 1870, p. 193;
Vogdes, Ann. New York Acad. Sci. 1889, vol. 5, p. 4;
Grabau, Ball. Buffalo Soc. Nat. Hist., 1899, vol. 6, p. 309;
Miller, N. A. Geol. and Paleo., 1st App., 1892, p. 709;
Ulrich, Geol. Minn., 1894, vol. 3, pt. 2, p. 681;
Eastman-Zittel, Textbook Paleo., 1913, p. 738;
Ulrich & Bassler, Md. Geol. Surv., 1913, Silurian, p. 315.

Moorea elongata Coryell and Sample, n. sp.

Plate XXIV, Fig. 19

Carapace small, subquadrangular in lateral view; about 2.26 times as long as high; valves apparently equal; dorsal margin straight; anterior margin rounded, truncated ventrally; posterior margin narrowly rounded with a backward swing in ventral half; mid-ventral margin concave with extremities, convexly rounded into anterior and posterior margins; end margins bordered by indistinct scroll-like ridge; surface convex, finely granulose; greatest height posterior.

Length, 0.48 mm.; height, 0.19 mm.

Holotype, Columbia University Paleo. Coll. No. 25256.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Genus AMPHISSITES Girty, 1910

Amphissites Girty, Ann. N. Y. Acad. Sci., 1910, vol. 20, p. 235.

Amphissites centronotus (Ulrich and Bassler) 1906

Plate XXV, Fig. 1

Kirkbya centronota Ulrich and Bassler, Proc. U. S. Nat. Mus., 1906, Bull. no. 1446, vol. 30, p. 159, pl. 9, figs. 16-17.

Amphissites centronota Harlton, Jour. Paleo., 1927, vol. 1, no. 3, p. 207, pl. 32, figs. 10a, b.

Amphissites centronotus Knight, Jour. Paleo., 1928, vol. 2, no. 3, p. 259, pl. 32, figs. 6a, e; pl. 34, fig. 2.
Delo, Jour. Paleo., 1930, vol. 4, no. 2, p. 160, pl. 12, fig. 9.
Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 66, pl. 5, figs. 4a, c.
Coryell & Osorio, Amer. Mid. Nat., 1932, vol. 13, no. 2, p. 30.

Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, no. 4, p. 184, pl. 18, fig. 9.

Carapace small, subquadrate in lateral view; cardinal angles slightly obtuse dorsal margin straight; hinge line depressed; anterior and posterior margins broadly rounded; ventral margin straight or gently convex; free margin on both valves carinate; surface granulose, coarsely reticulate; an inner carina is separated from marginal carina by two or three reticulations; a slightly curved carina is present anteriorly and posteriorly about four reticulations within the inner carina; a large hemispherical node is present in central position on the shell.

Length, 0.67 mm.; height, 0.40 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Amphissites girtyi Knight, 1928

Plate XXV, Fig. 4

Amphissites girtyi Knight, Jour. Paleo., 1928, vol. 2, p. 260, pl. 32, fig. 7a, b; pl. 34, fig. 1;

Warthin, Okla., Geol. Surv., 1930, Bull. 53, p. 65, pl. 5, fig. 3;
Coryell and Osorio, Amer. Mid. Nat., 1932, vol. 13, no. 2, p. 30.

Amphissites mesocostata Roth, Pub. Wagner Free Inst., 1929, vol. 1, p. 48, pl. 3, figs. 15a, c.

Carapace small, subquadrate; cardinal angles obtuse; hinge line straight; dorsal margin slightly concave; free margin defined in later view by a carina on each valve; surface reticulate; two or three reticulations from marginal carina, an inner carina which joins the dorsal margin at the cardinal angles; a well-defined anterior carina begins about two reticulations back of the inner carina on dorsal margin and extends slightly forward and downward for about five reticulations where it nearly dies out; posterior carina about six reticulations in front of the inner carina, extending downward for about ten reticulations from the dorsal margin; innermost carina connected dorsally by a carina; central node small, extending forward in a carina for about five reticulations where it gradually dies out.

Length, 0.57 mm.; height, 0.33 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Amphissites pinguis (Ulrich and Bassler) 1906

Plate XXV, Fig. 3

Kirkbya pinguis Ulrich and Bassler, Proc. U. S. Nat. Mus., 1906, no. 1446,, vol. 30, p. 159, pl. 11, figs. 13-15.

Amphissites pinguis Knight, Jour. Paleo., 1928, vol. 2, no. 3, p. 263, pl. 32, fig. 9; pl. 34, fig. 3;

Delo, Contrib. in Geol. Washington Univ. Studies, N. S. Sci. Tech., 1931, no. 5, p. 46, pl. 4, fig. 7 a, c.

Carapace small, suboblong in lateral view; dorsal margin straight; hinge line depressed at posterior end; height of anterior and posterior nearly the same; end margins broadly rounded so that dorsal and ventral margins are met without prominent angulations; ventral margin straight or very slightly convex; free margin of each valve in lateral view formed by a narrow carina; surface convex, reticulate; dorsal posterior swelling broad, low, poorly defined, rising higher than hinge line; central node low, indistinct, better located by means of the *Kirkbyan* pit which is found just below and slightly posterior to the node; greatest length in the middle; greatest thickness through area of central node.

Length, 0.82 mm.; height, 0.49 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Amphissites dattonensis Harlton 1927

Plate XXV, Fig. 2

Amphissites dattonensis Harlton, Jour. Paleo., 1927, vol. 1, no. 3, p. 206, pl. 32, fig. 9 a, b;

Harlton, Univ. of Texas, 1929, Bull. 2901, p. 149, pl. 1, fig. 9 a, b;

Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 64, pl. 4, fig. 15;

Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, no. 4, p. 184, pl. 18, fig. 8.

Carapace small, subquadrate in lateral view; dorsal margin irregular; hinge more depressed in area of posterior nodes; anterior and posterior margins broadly rounded; ventral margins straight or slightly concave; free margin characterized in each valve by the presence of a strong, narrow

carina; surface reticulate, posterior node nearly vertical, about five reticulations from the posterior margin, abrupt on posterior side, gently sloping on the anterior side, slightly carinate; central node low, poorly defined, anterior of real center of shell; inner ventral carina parallel to and about three reticulations above the ventral margin, extending from just below posterior node to a point some three or four reticulations from the anterior margin where it gradually dies out.

Length, 0.67 mm.; height, 0.43 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Amphissites irregularis Coryell and Sample, n. sp.

Plate XXV, Fig. 5

Carapace small, subtrapezoidal in lateral view; dorsal margin concave in central portion, abruptly indented near posterior end; hinge line depressed, straight; anterior margin broadly rounded; posterior margin evenly rounded but more narrowly than the anterior; ventral margin slightly concave; free margin of each valve characterized by a narrow, well defined carina which extends along the dorsal border as a faint ridge; posterior node is a pronounced vertical ridge, approximately extending downward for about two-thirds the height of the shell; inner ventral carina begins just below the posterior node and extends parallel to the margin of the shell until it gradually dies out about one-fourth the length of the shell from the anterior end; central node prominent with a very steep posterior slope that usually is crested; greatest height anterior.

Length, 0.42 mm.; height, 0.25 mm.

Holotype, Columbia University Paleo. Coll. No. 25257.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Family BAIRDIIDAE Brady and Norman, 1892

Genus BAIRDIA McCoy, 1844

Bairdia McCoy, Syn. Carb. Limestone Foss. Ireland, 1844, p. 165, pl. 23, fig. 6.

Bairdia hispida Harlton, 1928

Plate XXV, Fig. 10

Bairdia hispida Harlton, Jour. Paleo., 1928, vol. 2, no. 2, p. 140, pl. 21, fig. 14;

Harlton, Univ. of Texas, 1929; Bull. 2901, p. 155, pl. 3, figs. 2 a, b; Delo, Jour. Paleo., 1930, vol. 4, no. 2, p. 163, pl. 12, fig. 14.

Carapace small, subrhomboidal in lateral view, about 1.6 times as long as high; dorsal margin convex, rounded; anterior acutely rounded; posterior beak bluntly angular; ventral margin straight or only slightly convex except at the ends where it curves upward to meet the anterior and posterior borders; dorsal overlap moderately strong, greatest in middle portion; ventral overlap nominal, stronger in central portion; surface finely granulose, regularly convex; greatest convexity near center of shell; greatest height central.

Length, 0.79 mm.; height, 0.52 mm.

Locality: Mineral Wells shale pit; Mineral Wells, Texas.

Bairdia seminalis Knight, 1928

Plate XXV, Fig. 14

Bairdia seminalis Knight, Jour. Paleo., 1928, vol. 2, no. 4, p. 320, pl. 43, figs. 2 a, d.

Carapace small, subovate in lateral view; about 1.6 times as long as high; dorsal margin crescent-shaped; anterior margin evenly rounded into dorsal and ventral margins; posterior beak bluntly angular; ventral margin evenly convex except near the posterior where it is drawn upward to meet the dorsal posterior slope; dorsal overlap moderate, and about the same all along the margin; ventral overlap narrow and less than the dorsal; surface smooth, evenly convex; greatest height central.

Length, 0.41 mm.; height, 0.25 mm.

Locality: Three miles west of Mineral Wells, Texas.

Bairdia angulata Coryell and Sample, n. sp.

Plate XXV, Fig. 16

Carapace small, subrhomboidal in lateral view, about 1.8 times as long as high; dorsal margin subangular, straight or

slightly concave, anterior slope is about one-third length of shell; posterior slope gentle until it reaches a point about one-fourth the length of the shell from the posterior end where it is angulated into a steeper slope; anterior short, truncated, abrupt; posterior narrow, abrupt, truncated; ventral margins straight in posterior two-thirds, bent upward in anterior one-third; overlap moderately strong dorsally, extends nearly the entire length of dorsal border; ventral overlap narrow; surface finely granulose, strongly convex, regular; greatest height about one-third the length of the shell from the anterior end.

Length, 0.41 mm.; height, 0.18 mm.

Holotype, Columbia University Paleo. Coll. No. 25258.

Locality: Three miles west of Mineral Wells, Texas.

Bairdia auricula Knight, 1928

Plate XXV, Fig. 6

Bairdia auricula Knight, Jour. Paleo., 1928, vol. 2, no. 4, p. 319, pl. 43, fig. 3 a, b.

Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 68, pl. 5, fig. 7 a, b.

Bairdia dornickbillensis Harlton (*B. pottsvil'ensis* in explanation of plate 2), Amer. Jour. Sci., ser. 5, vol. 18, 1929, p. 268, pl. 2, fig. 12.

Carapace small, subrhomboidal in lateral view, moderately convex in dorsal view; dorsal margin high, anterior slope gentle, concave or straight; posterior slope gentle until last quarter of the shell is reached, where it is increased by a distinct angulation; anterior margin rounded with ventral portion truncated; posterior rounded, acuminate; ventral margin only slightly convex, with pronounced terminal upward curves where it meets the anterior and posterior borders; overlaps strongest on the anterior dorsal slope; ventral overlap strong along central portion of shell; surface finely granulose; greatest height just anterior to the middle portion of the dorsal margin.

Length, 0.50 mm.; height, 0.34 mm.

Locality: Mineral Wells shale pit, and three miles west of Mineral Wells, Texas.

Bairdia rogatzi Coryell and Sample, n. sp.

Plate XXV, Fig. 7

Carapace large, suboval in lateral view, elongate; about two and one-third times as long as high; dorsal margin gently convex; anterior margin evenly rounded into the dorsal and ventral margins; posterior margin more acutely rounded than anterior; not acuminate; ventral margin straight or slightly concave; surface granulose, evenly convex; dorsal overlap of nearly equal width along the greater part of the dorsal margin; ventral overlap strong centrally, and less posteriorly and anteriorly.

Length, 1.10 mm.; height, 0.49 mm.

Holotype, Columbia University Paleo. Coll. No. 25259.

Locality: Mineral Wells shale pit, and three miles west of Mineral Wells, Texas.

This species is not as long or posteriorly acuminate as *Bairdia haworthi* Knight, and differs from *Bairdia acetalata* Coryell and Billings in having an arched posterior dorsal marginal slope.

Bairdia oklahomaensis Harlton, 1927

Plate XXV, Fig. 9

Bairdia oklahomaensis Harlton, Jour. Paleo., 1927, vol. 1, no. 3, p. 209, pl. 33, fig. 7;

Harlton, Univ. of Texas, 1929, Bull. 2901, p. 156, pl. 3, fig. 5a;

Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 68, pl. 5, fig. 8 a, b;

Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, p. 172, pl. 17, fig. 3.

Carapace large, subrhomboidal in lateral view, relatively thin and moderately convex in dorsal view; dorsal margin high, anterior slope gently, posterior slope increased by a slight angulation near the middle of the slope; anterior margin rounded, ventrally truncated; posterior acuminate; ventral margin nearly straight except where it slopes upward to meet the posterior and anterior slopes; dorsal overlap strong, strongest centrally; surface granulose; greatest height slightly posterior to the middle.

Length, 1.25 mm.; height, 0.76 mm.

Locality: Mineral Wells shale pit, and three miles west of Mineral Wells, Texas.

Bairdia oklahomaensis differs from *Bairdia auricula* in location of greatest height, location of greatest dorsal overlap, and more elongate character of the former.

Bairdia ciscoensis Harlton, 1927

Plate XXV, Fig. 8

Bairdia ciscoensis Harlton, Jour. Paleo., 1927, vol. 1, no. 3, p. 210, pl. 33, fig. 8.

Carapace small, subrhomboidal in lateral view, length about 1.6 times the height; dorsal border arched, anterior slope nearly straight, posterior margin slightly convex; anterior narrowly rounded near the dorsal border and broadly truncated towards the ventral border; posterior extremity acuminate; ventral margin very broadly convex, centrally with the ends pronouncedly curved upward; overlap strong along dorsal border, moderate along ventral border; surface finely granulose, evenly convex; greatest height about one-third the length of the shell from the anterior.

Length, 0.70 mm.; height, 0.40 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Bairdia ciscoensis is more acuminate posteriorly than *Bairdia oklahomaensis.*

Genus BYTHOCYPRIS Brady, 1880

Bythocypris, G. S. Brady, Rep. Voy. Challenger, Zool., 1880, vol. 1, p. 45, pl. 5, fig. 1.

Bythocypris centralis Coryell and Billings, 1932

Plate XXV, Fig. 12

Bythocypris centralis Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, p. 174, pl. 17, fig. 11.

Carapace small, subpediform in lateral view; about 1.8 times as long as high; dorsal margin gently convex; anterior well rounded; posterior margin nearly vertical; ventral mar-

gin straight except for upward curve near posterior; anterior height slightly lower than posterior height; surface smooth, evenly convex; greatest height central.

Length, 0.53 mm.; height, 0.28 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Bythocypris parallela Knight, 1928
Plate XXV, Fig. 11

Bythocypris parallela Knight, Jour. Paleo., 1928, vol. 2, no. 4, Dec., p. 327, pl. 44, figs. 2 a, b.

Carapace small, narrow in lateral view; about twice as long as high; dorsal margin gently convex; anterior margin evenly rounded; posterior margin begins at beak and curves upward and anteriorly into dorsal margin; ventral margin straight or slightly concave, except for upward slope in posterior portion; beak formed by intersection of posterior and ventral margins; overlap narrow all the way around; surface finely granulose, convex; greatest height central.

Length, 0.53 mm.; height, 0.27 mm.

Locality: Mineral Wells shale pit; and three miles west of Mineral Wells, Texas.

Bythocypris texensis Coryell and Sample, n. sp.
Plate XXV, Fig. 13

Carapace small, subpediform in lateral view; length about 1.6 times height; dorsal margin curved, sloping gently anteriorly and posteriorly; anterior rounded; posterior truncated dorsally, and forms an angular beak at the contact with the margin; the ventral margin is straight or slightly concave except at the posterior end where it curves upward for a short distance; overlap nominal, greatest ventrally and dorsally; surface finely granulose; greatest height central or slightly posterior; greatest thickness in postero-dorsal quadrant.

Length, 0.52 mm.; height, 0.27 mm.

Holotype, Columbia University Paleo. Coll. No. 25260.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Bythocypris palopintoensis Coryell and Sample, n. sp.
Plate XXV, Fig. 17

Carapace small, subovate in lateral view; length about 1.6 times height; dorsal margin convex, sloping very gently anteriorly and posteriorly; anterior rounded; posterior margin sloping from posterior extremity of shell upward and anteriorly for about one-fifth the length of the shell; ventral margin slightly concave, centrally; posterior beak rounded; overlap greatest antero-dorsally and centro-ventrally, surface finely granulose, evenly convex; greatest height slightly anterior of center; height of end nearly equal and not greatly less than the greatest height.

Length, 0.67 mm.; height, 0.36 mm.

Holotype, Columbia University Paleo. Coll. No. 25261.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Bythocypris pediformis Knight, 1928
Plate XXV, Fig. 18

Bythocypris pediformis Knight, Jour. Paleo., 1928, vol. 2, no. 4, p. 326, pl. 44, fig. 3a - c;
Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 74, pl. 6, fig. 6a - b.

Carapace small, subpediform in lateral view; length about 1.7 times height; dorsal margin gently curved toward anterior extremity from a point about four-fifths the length of the shell from the anterior; anterior curved; posterior margin curves almost vertically to form an angulated beak at its intersection with the ventral margin; ventral margin straight except for curve upward to meet posterior margin; surface finely granulose; greatest height just anterior to break in curvature of dorsal margin; greatest thickness median in line of greatest height.

Length, 0.52 mm.; height, 0.32 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Bythocypris semicirculus Coryell and Sample, n. sp.
Plate XXV, Fig. 15

Carapace small, subsemicircular in lateral view; about

1.55 times as long as high; dorsal margin crescentic; anterior and posterior ends low; ventral margin slightly convex; surface finely granulose and regularly convex; overlap narrow on both ventral and dorsal margins; greatest height central; greatest length in ventral half of the shell.

Length, 0.27 mm.; height, 0.18 mm.

Holotype, Columbia University Paleo. Coll. No. 25263.

Locality: Three miles west of Mineral Wells, Texas.

Genus HEALDIA Roundy, 1926

Healdia Roundy, U. S. Geol. Surv., 1926, Prof. Paper 146, p. 8, pl. 1, fig. 11.

Healdia simplex Roundy, 1926

Plate XXVI, Fig. 1

Healdia simplex Roundy, U. S. Geol. Surv., 1926, Prof. Paper 146, p. 8, pl. 1, figs. 11a - c;

Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, p. 179, pl. 17, fig. 15.

Carapace small, subdeltoid in lateral view; dorsal margin straight or slightly convex on anterior slope, concave on postal slope; anterior margin well rounded; posterior margin subangular, rounded, truncated ventrally; ventral margin straight, slightly upcurved at ends; overlaps narrow ventrally, and widest antero-dorsally; posterior ridges nearly flush with convexity of valve on anterior side and marks the crest of a steeper slope on the posterior side; greatest height central.

Length, 0.46 mm.; height, 0.32 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Healdia oklahomaensis Harlton, 1927

Plate XXVI, Fig. 4

Healdia oklahomaensis Harlton, Jour. Paleo., 1927, vol. 1, no. 3, p. 208, pl. 33, figs. 3a - c;

Harlton, Amer. Jour. Sci., 1929, ser. 5, vol. 18, p. 263, pl. 2, fig. 5.

Carapace small, subdeltoid in lateral view; dorsal margin highest centrally, anterior slope convex; posterior slope con-

cave; anterior margin well rounded; posterior margin low and curved; ventral margin nearly straight; overlap prominent, on dorsal-anterior, anterior and ventral margins; spines in posterior-dorsal and posterior-ventral areas prominent.

Length, 0.54 mm.; height, 0.35 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Healdia glennensis Harlton, 1927

Plate XXVI, Fig. 6

Healdia glennensis Harlton, Jour. Paleo., 1927, vol. 1, no. 3, p. 209, pl. 33, fig. 6a - b;

Harlton, Amer. Jour. Sci., 1929, ser. 5, vol. 18, p. 263, pl. 2, fig. 4.

Carapace small, subdeltoid in lateral view; slightly elongate; dorsal margin highest in center; anterior slope convex, posterior slope nearly straight; posterior margin narrowly rounded; anterior more broadly rounded; ventral margin straight or slightly concave; posterior spines small, acute, and without connecting crest; dorsal posterior spine distinctly anterior of the ventral posterior spine; overlap narrow.

Length, 0.50 mm.; height, 0.32 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Healdia cuneata Coryell and Billings, 1932

Plate XXVI, Fig. 2

Healdia cuneata Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, p. 178, pl. 18, fig. 14.

Carapace small, subcylindrical in shape; dorsal margin gently convex, greatest height central; posterior end curved, abrupt, truncated; anterior end broadly curved; ventral nearly straight, except at the ends where it swings up to meet the posterior and anterior margins; posterior ridge overhanging posteriorly; small spines, widely separated, and near dorsal and ventral ends of the posterior ridge; greatest thickness at posterior ridge.

Length, 0.40 mm.; height, 0.24 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Healdia alba Coryell and Billings, 1932

Plate XXVI, Fig. 3

Healdia alba Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, p. 178, pl. 18, fig. 13.

Carapace small, subdeltoid in lateral view; dorsal margin high, convex anteriorly, and concave posteriorly; posterior margin narrowly curved; anterior broadly rounded; ventral margin slightly convex; posterior spines prominent, and widely separated occurring near the posterior-dorsal and posterior-ventral corners; overlap very narrow; greatest height central; anterior height only slightly greater than the posterior height.

Length, 0.35 mm.; height, 0.26 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Healdia formosa Harlton, 1928

Plate XXVI, Fig. 7

Healdia formosa Harlton, Jour. Paleo., 1928, vol. 2, no. 2, p. 135, pl. 21, figs. 7a - b; (not Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 77, pl. 6, fig. 13 a - b).

Carapace small, elongate; dorsal margin arched, highest centrally, anterior gently convex, posterior slope nearly straight; posterior margin acutely rounded; anterior margin broadly rounded; ventral gently convex or straight; posterior spines short or long, located in posterior-dorsal and posterior-ventral corners.

Length, 0.46 mm.; height, 0.27 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Healdia longa Knight, 1928

Plate XXVI, Fig. 5

Healdia longa Knight, Jour. Paleo., 1928, vol. 2, no. 4, p. 332, pl. 44, figs. 6a - c; (not Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 75, pl. 6, fig. 10).

Carapace small, elongate, broadly subovate in lateral view; dorsal anterior margin broadly convex; posterior-dorsal nearly straight; anterior margin regularly curved; ventral margin straight; posterior ridge is short, low, and near the posterior margin; no spines are present; greatest height central.

Length, 0.40 mm.; height, 0.21 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Family CYTHERELLIDAE Sars

Genus CYTHERELLA Jones, 1849

Cytherella Jones, Paleo. Soc., 1849, Mono., p. 28.

Cytherella tongia Coryell and Sample, n. sp.

Plate XXVI, Fig. 11

Carapace small, subelliptical in lateral view; length 1.8 times the height; dorsal border broadly curved; posterior end narrowly curved above median part of shell, and truncated below; anterior end broadly rounded, its greatest extension well below that of the posterior end; ventral border straight or slightly concave centrally; overlap of the right valve somewhat greater on the dorsal and ventral margins; surface finely granulose, convex; greatest thickness slightly posterior of center; greatest height near the middle of the valve.

Length, 1.05 mm.; height, 0.59 mm.

Holotype, Columbia University Paleo. Coll. No. 25264.

Locality: Three miles west of Mineral Wells, Texas.

Cytherella gloria Coryell and Sample (new name)

Plate XXVI, Fig. 14

Cytherella intermedia Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 78, pl. 7, fig. 1a - b.

Cytherella benniei intermedia Jones, Kirkby and Brady, Paleo. Soc., 1884, Mono., p. 78, pl. 7, fig. 7;

Delo, Contrib. Geol. Washington University Studies, Sci. Tech., no. 5, p. 50, pl. 4, fig. 10; (not *Cytherella intermedia* Bornemann, Zeitsch. Deutsch. Geol. Gesell., 1855, p. 355, pl. 20, fig. 3).

Carapace small, subelliptical in lateral view; length 1.7 times the height; posterior-dorsal border slightly convex; anterior end broadly rounded, its furthest extension is lower than that of the posterior end; ventral border broadly convex, meeting the posterior end in a blunt angle; overlap of the right valve greatest on the dorsal and ventral margins; surface granulose; greatest thickness slightly posterior to the center; greatest height slightly anterior to the center.

Length, 0.91 mm.; height, 0.55 mm.

Holotype, Columbia University Paleo. Coll. No. 25265.

Locality: Mineral Wells shale pit, and three miles west of Mineral Wells, Texas.

Cytherella wewokena Warthin, 1930
Plate XXVI, Fig. 13

Cytherella wewokena Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 77, pl. 7, fig. 2a - b.

Carapace short, subovate in lateral view with the greatest height very slightly in front of the middle; greatest thickness is a little posterior of the center along the median line; dorsal margin arched with the posterior sloping more steeply than the anterior; greatest posterior extension is well above the median line of length and narrowly curved; posterior ventral, truncated in a broad curve; the anterior margin is broadly and regularly curved with a narrow and regular overlap appearance of the right valve; overlap greatest at the crest of the dorsal border; the ventral border is broadly convex with a narrow overlap; surface of valves smooth.

Length, 1.0 mm.; height, 0.6 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Cytherella watkinsi Coryell and Sample, n. sp.
Plate XXVI, Fig. 8

Carapace small, subovate in lateral view; length about 1.5 times the height; dorsal margin broadly rounded, posterior dorsal slope very slightly steeper than the anterior dorsal slope; posterior margin more narrowly rounded, than the anterior margin, with greatest extension slightly higher than median line of the shell; ventral margin gently convex, and passes into the end margin in a regular uniform curve; dorsal and ventral overlaps narrow but greater than elsewhere; surface smooth, strongly convex; greatest height median; greatest thickness near the center of the posterior half.

Length, 0.60 mm.; height, 0.42 mm.

Holotype, Columbia University Paleo. Coll. No. 25266.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Cytherella proxima Coryell and Sample, n. sp.
Plate XXVI, Fig. 9

Carapace small, short, and subovate in lateral view; length about 1.5 times the height; dorsal margin arched; the anterior dorsal margin slopes less steeply than the posterior; anterior rounded broadly; posterior rather acutely rounded, with greatest extension slightly higher than the median line of the

shell; ventral margin gently convex; ventral and dorsal overlap is a little stronger than elsewhere; anterior and posterior overlap very narrow; surface smooth, strongly convex; greatest height in median portion; greatest thickness near the center of the posterior half.

Length, 0.58 mm.; height, 0.38 mm.

Holotype, Columbia University Paleo. Coll. No. 25267.

Locality: Three miles west of Mineral Wells, Texas.

Genus CAVELLINA Coryell, 1928

Cavellina Coryell, Jour. Paleo., 1928, vol. 2, no. 2, p. 89.

Cavellina lintris Coryell and Sample, n. sp.

Plate XXVI, Fig. 12

Carapace small, short, ovate in lateral view; length about 1.6 times the height; dorsal margin arched, greatest height near the center; posterior end rounded, moderately acute; anterior end evenly rounded; ventral margin only slightly less convex than dorsal; overlap of right valve strong in central portions of dorsal and ventral overlaps, narrow posteriorly, and anteriorly; surface finely punctate; greatest thickness about one-fifth the length of the shell from the posterior end.

Length, 1.04 mm.; height, 0.70 mm.

Holotype, Columbia University Paleo. Coll. No. 25268.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Cavellina lintris is distinguished from *Cavellina pulchella* in the distribution of the maximum overlap, length-height ratio, and general outline as seen in lateral view.

Cavellina pulchella Coryell, 1928

Plate XXVI, Fig. 15

Cavellina pulchella Coryell, Jour. Paleo., 1928, vol. 2, p. 90, pl. 11, fig. 5; Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 78, pl. 7, fig. 3a - b; Coryell and Billings, Amer. Mid. Nat., 1932, vol. 13, p. 181, pl. 17, fig. 16.

Carapace small, subreniform in lateral view; length about one and one-half times height; dorsal margin arched, greatest height near center; posterior end acutely rounded; anterior end broadly rounded; ventral margin broadly convex; overlap of right valve nominal, greater centrally; surface finely

granulose; greatest thickness about one-fifth the length of the shell from the posterior end.

Length, 0.97 mm.; height, 0.60 mm.

Locality: Three miles west of Mineral Wells, Texas.

Cavellina reversa Coryell, 1928

Plate XXVI, Fig. 10

Cavellina reversa Coryell, Jour. Paleo., 1928, vol. 2, no. 2, p. 92, pl. 11, fig. 7;

Warthin, Okla. Geol. Surv., 1930, Bull. 53, p. 80, pl. 7, fig. 6a - b.

Carapace small, subreniform in lateral view; length about times the height; dorsal margin broadly arched; posterior end moderately acute, rounded; anterior end rounded; ventral margin more convex than the dorsal margin; overlap of right valve on dorsal and ventral margins narrow; surface finely granulose; greatest thickness about one-fifth the length of the shell from the posterior end.

Length, 0.77 mm.; height, 0.44 mm.

Locality: Three miles west of Mineral Wells, Texas.

Cavellina jejuna Coryell and Sample, n. sp.

Plate XXVI, Fig. 16

Carapace small, subreniform in lateral view; length about 1.7 times the height; dorsal margin arched, greatest height anterior to center; posterior end acutely rounded with ventral portion steeply truncated; anterior end broadly rounded; ventral slightly convex; overlap of right valve greatest on dorsal anterior margin, and rather wide along the straight portion of ventral margin; surface finely granulose; greatest thickness near posterior margin.

Length, 0.60 mm.; height, 0.35 mm.

Holotype, Columbia University Paleo. Coll. No. 25269.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

This species differs from other described forms in the location of the greatest height, steepness of the posterior ventral truncation, and distribution of the overlap of the larger valve.

Genus **Sulcella** Coryell and Sample, n. g.

Genotype *Sulcella sulcata* Coryell and Sample, n. sp.

Carapace small, cytherelloid in outline and contact of valves; hinge line arched; right valve extending beyond the

margin of the left all around except along the anterior; the anterior margin bordered by a distinct ridge separated from the regular convexity of the valve by a narrow groove. The surface smooth except for the shallow sulcus that extends from the dorsal margin to a pronounced submedian pit.

Range — Pennsylvanian.

Sulcella sulcata Coryell and Sample, n. sp.
Plate XXVI, Fig. 18

Carapace small, subovate in lateral view, elongate; anterior margin about 1.8 times height; dorsal margin slightly convex; anterior margin regularly rounded; contact with dorsal margin curved; posterior margin narrowly rounded; ventral margin straight or slightly convex; surface very finely granulose; sulcus shallow ending in a deep pit that lies slightly anterior and dorsal of the middle of the valve; greatest thickness of shell near the posterior end, from which the slope to the posterior contact is steep and slightly concave; greatest height nearly central.

Length, 0.98 mm.; height, 0.40 mm.

Holotype, Columbia University Paleo. Coll. No. 25254.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

Sulcella warthini Coryell and Sample, n. sp.
Plate XXVI, Fig. 17

Jonesina texana Warthin, (not *Jonesina texana* Harlton) Okla. Geol. Surv., 1930, Bull. 53, p. 60, pl. 4, fig. 10.

Carapace small, suboval, cytherelloid in outline and contact characteristics; dorsal margin convex; ventral margin straight or slightly concave; the anterior margin regularly rounded with a narrow marginal rim bordering the valves; posterior margin narrowly rounded dorsally and truncated ventrally; surface of the valve is smooth, marked by a pronounced sulcus slightly posterior and dorsal of the center; the greatest convexity of the valve is in the ventral half with the maximum thickness near the posterior end; posterior slope of the valve from the location of greatest thickness to the posterior margin is steep, concave and apparently crested with a low rounded ridge.

Length, 0.55 mm.; height, 0.3 mm.

Locality: Mineral Wells shale pit, Mineral Wells, Texas.

PLATE XXIV.

Figure — Page

1. *Paraparchites thomasi* Coryell and Sample, n. sp. ---- 248
   x 60 (right valve)
2. *Paraparchites latidorsatus* Warthin ---- 249
   x 40 (right valve)
3. *Paraparchites oblongus* Coryell and Sample, n. sp. ---- 250
   x 60 (right valve)
4. *Paraparchites palopintoensis* Coryell and Sample, n. sp. ---- 248
   x 60 (right valve)
5. *Paraparchites brazoensis* Coryell and Sample, n. sp. ---- 249
   x 65 (left valve)
6. *Cornigella minuta* Warthin ---- 253
   x 65 (left valve)
7. *Hollinella bulbosa* Coryell and Sample, n. sp. ---- 251
   x 30 (right valve)
8. *Hollinella harltoni* Kellett ---- 251
   x 60 (right valve)
9. *Hollites papillosus* Coryell and Sample, n. gen., n. sp. ---- 252
   x 40 (left valve)
10. *Jonesina acuneata* Warthin ---- 254
    x 40 (right valve)
11. *Kirkbyina laevis* Warthin ---- 256
    x 60 (left valve)
12. *Cornigella longispina* Coryell and Sample, n. sp. ---- 254
    x 105 (left valve)
13. *Jonesina texana* Harlton ---- 255
    x 45 (left valve)
14. *Jonesina ampla* Warthin ---- 255
    x 40 (right valve)
15. *Hollinella digitata* Kellett ---- 250
    x 30 (right valve)
16. *Moorites parallela* Coryell and Sample, n. sp. ---- 257
    x 70 (left valve)
17. *Moorites hewetti* Coryell and Billings ---- 257
    x 65 (right valve)
18. *Moorites minutus* (Warthin) ---- 256
    x 65 (left valve)
19. *Moorea elongata* Coryell and Sample, n. sp. ---- 258
    x 60 (right valve)

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PLATE XXIV.

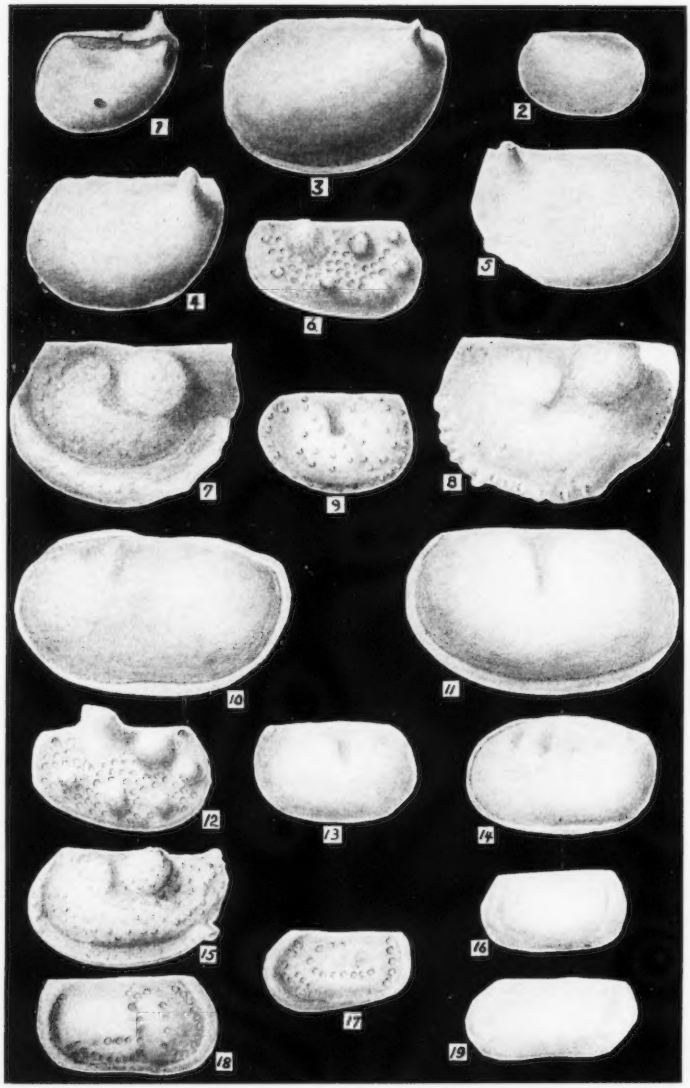

PLATE XXV.

Figure — Page

1. *Amphissites centronotus* (Ulrich and Bassler) ---- 258
   x 60 (left valve)
2. *Amphissites dattonensis* Harlton ---- 260
   x 35 (right valve)
3. *Amphissites pinguis* (Ulrich and Bassler) ---- 260
   x 35 (right valve)
4. *Amphissites girtyi* Knight ---- 259
   x 55 (right valve)
5. *Amphissites irregularis* Coryell and Sample, n. sp. ---- 261
   x 65 (left valve)
6. *Bairdia auricula* Knight ---- 263
   x 65 (right valve)
7. *Bairdia rogatzi* Coryell and Sample, n. sp. ---- 264
   x 30 (right valve)
8. *Bairdia ciscoensis* Harlton ---- 265
   x 40 (right valve)
9. *Bairdia oklahomaensis* Harlton ---- 264
   x 30 (right valve)
10. *Bairdia hispida* Harlton ---- 262
    x 35 (right valve)
11. *Bythocypris parallela* Knight ---- 266
    x 65 (right valve)
12. *Bythocypris centralis* Coryell and Billings ---- 265
    x 65 (right valve)
13. *Bythocypris texensis* Coryell and Sample, n. sp. ---- 266
    x 70 (right valve)
14. *Bairdia seminalis* Knight ---- 262
    x 65 (right valve)
15. *Bythocypris semicirculus* Coryell and Sample, n. sp. ---- 267
    x 150 (right valve)
16. *Bairda angulata* Coryell and Sample, n. sp. ---- 262
    x 80 (right valve)
17. *Bythocypris palopintoensis* Coryell and Sample, n. sp. ---- 267
    x 60 (right valve)
18. *Bythocypris pediformis* Knight ---- 267
    x 60 (right valve)

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PLATE XXV.

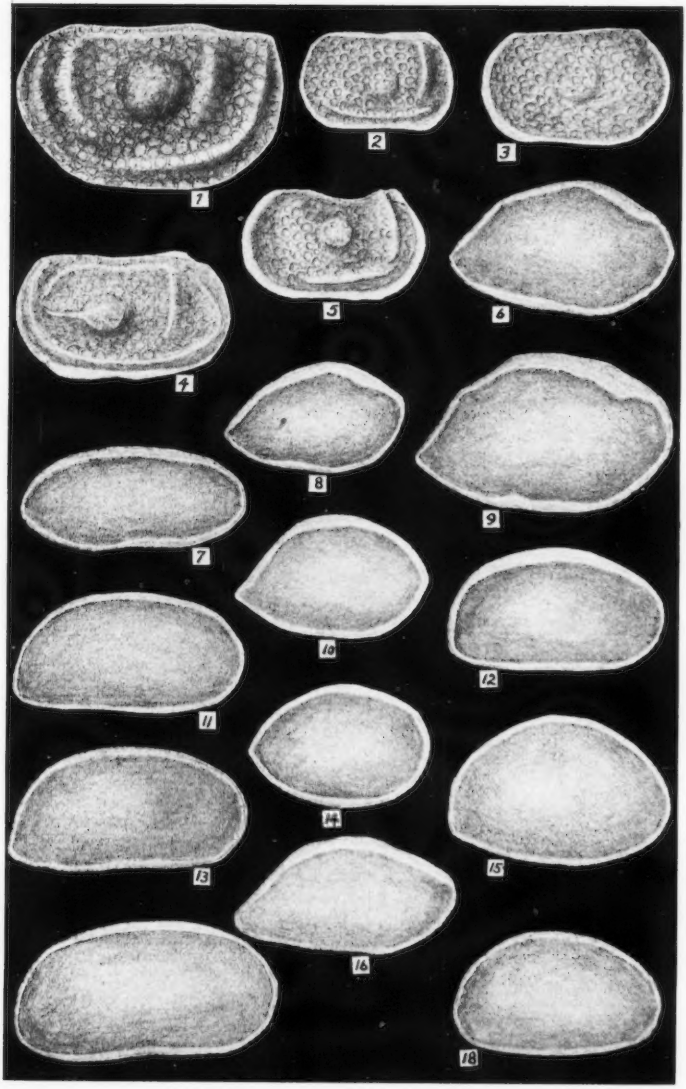

PLATE XXVI.

Figure — Page

1. *Healdia simplex* Roundy ---- 268
   x 65 (right valve)
2. *Healdia cuneata* Coryell and Billings ---- 269
   x 65 (right valve)
3. *Healdia alba* Coryell and Billings ---- 270
   x 80 (right valve)
4. *Healdia oklahomaensis* Harlton ---- 268
   x 60 (right valve)
5. *Healdia longa* Knight ---- 270
   x 65 (right valve)
6. *Healdia glennensis* Harlton ---- 269
   x 70 (right valve)
7. *Healdia formosa* Harlton ---- 270
   x 65 (right valve)
8. *Cytherella watkinsi* Coryell and Sample, n. sp. ---- 272
   x 50 (left valve)
9. *Cytherella proxima* Coryell and Sample, n. sp. ---- 272
   x 60 (left valve)
10. *Cavellina reversa* Coryell ---- 274
    x 30 (left valve)
11. *Cytherella tongia* Coryell and Sample, n. sp. ---- 271
    x 40 (left valve)
12. *Cavellina lintris* Coryell and Sample, n. sp. ---- 273
    x 30 (left valve)
13. *Cytherella wewokana* Warthin ---- 272
    x 30 (left valve)
14. *Cytherella gloria* Coryell and Sample, n. sp. ---- 271
    x 40 (left valve)
15. *Cavellina pulchella* Coryell ---- 273
    x 30 (left valve)
16. *Cavellina jejuna* Coryell and Sample, n. sp. ---- 274
    x 60 (left valve)
17. *Sulcella warthini* Coryell and Sample, n. sp. ---- 275
    x 50 (left valve)
18. *Sulcella sulcata* Coryell and Sample, n. gen., n. sp. ---- 275
    x 30 (left valve)

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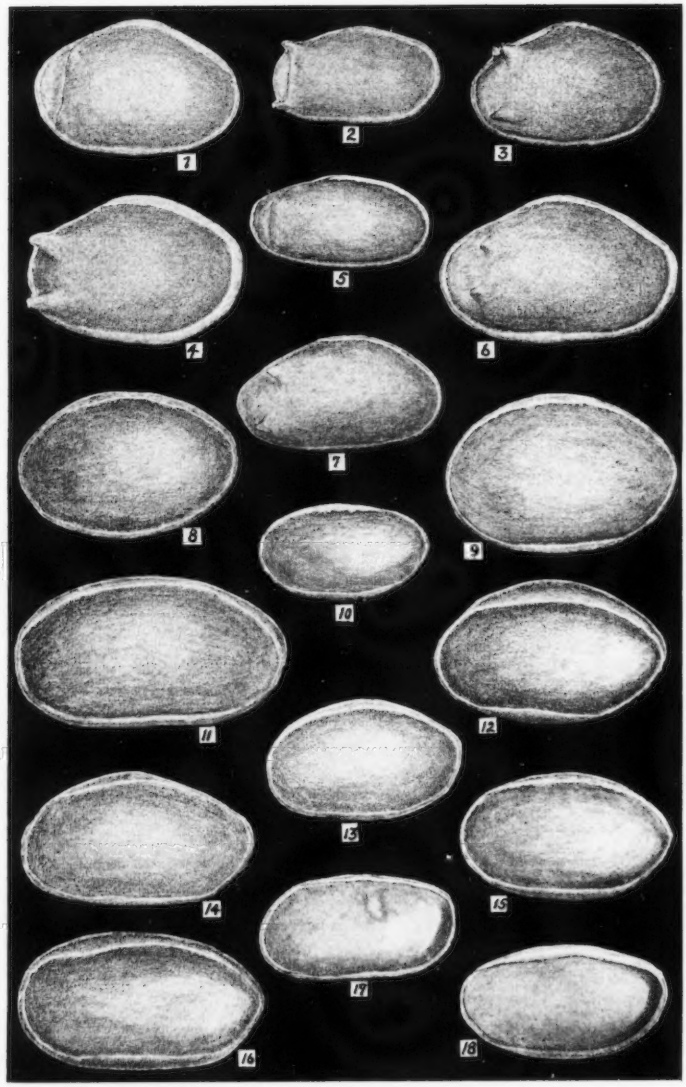
PLATE XXVI.



THE BRAZER FORMATION OF NORTHERN UTAH AND ITS TELOTREMATE BRACHIOPODS

FRANK H. GUNNELL

I. INTRODUCTION

This paper summarizes an investigation of 24 species of brachiopods and the strata from which they were collected. The collections and field study were made in the summer of 1929 under the supervision of Professor R. W. Bailey of the Utah State Agriculture College. The specimens were studied at the University of Missouri during the winter of 1929-30, the identifications being checked by Dr. E. B. Branson.

II. THE BRAZER FORMATION

A. NAME AND DISTRIBUTION

The Brazer formation was named by Richardson[1] from Brazer Canyon, in the Crawford Mountains, Randolph quadrangle, Utah. The Brazer is known to occur at various places in northern Utah and eastern Idaho. The investigations of the writer were confined chiefly to the exposures which occur in the Wellsville and Bear River Mountains of northern Utah.

B. AGE AND CORRELATION

Mansfield[2] has called the Brazer Upper Mississippian, upon the basis of fossils identified from outcrops in southeastern Idaho and northeastern Utah. Data presented in this paper indicate that this formation contains species which are equivalent to fossils that occur in the Amsden of Wyoming, the Maroon of Colorado, and the Ste. Genevieve and Chester of the Mississippi Valley, all of upper Mississippian age.

C. CHARACTER AND RELATIONSHIPS

At all exposures where the lower Brazer was studied it is underlain by the Madison limestone of lower Mississippian age. The contact between the two is moderately sharp and occurs at the base of the Brazer phosphatic shale member. Subangular chert pebbles were found in the basal part of this

[1] Richardson, G. B., The Paleozoic section in northern Utah: Am. Jour. Sci., 4th ser., vol. 36, pp. 406-416, 1910.

[2] Mansfield, G. R., Geography, Geology, and Mineral Resources of Part of Southeastern Idaho: U. S. Geol. Surv. Prof. Paper 152, p. 63, 1927.

shale in the Logan quadrangle. There is no difference in the attitude of beds above and below the contact insofar is the writer could determine.

The Brazer is overlain by the Wells formation of Pennsylvanian age. Although some geologists have referred to the contact as uncomfortable the writer has not found evidence of an erosional interval.

The Telotremata found in the Brazer indicate that sedimentation was continuous from upper Mississippian into lower Pennsylvanian in this region. For example, *Dielasma* sp. occurs below the horizon where is found *Productus brazerianus*, a typical Brazer brachiopod. The former species also occurs in the Wells formation. Although many species occur in the Wells that are not found in the Brazer there are some which are common to both formations. This intermingling of faunas makes it impossible to designate the boundary between the Brazer and the Wells from the evidence at hand.

The Brazer consists of limestone, shale, sandstone, quartzite, and siltstone. In general, shale interbedded with sandstone forms the lower part, but in places there is quartzite rather than sandstone. The middle part, about one-third of the formation, is limestone, and the upper part is shale interbedded with limestone.

Richardson[3] notes that in the Randolph quadrangle of northeastern Utah the Brazer formation is more or less sandy throughout, and that locally considerable sandstone is present. Mansfield[4] reports that in southeastern Idaho the Brazer limestone probably contains a somewhat higher percentage of calcareous matter, though there, too, cherty material, sandy beds, and sandstone are found. Near the top a dark shale is also present. Mansfield[5] has described the Brazer that occurs in the Portneuf quadrangle, Idaho, as characterized chiefly by massive generally light gray limestone that is prominent as a ridge- and cliff-maker and that in certain beds is highly fossiliferous.

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[3] Richardson, G. B., op. cit., pp. 406-416.

[4] Mansfield, G. R., op. cit., p. 63.

[5] Mansfield, G. R., Geography, Geology, and Mineral Resources of the Portneuf Quadrangle, Idaho: U. S. Geol. Survey Bulletin 803, p. 25, 1929.

In the Logan quadrangle, Utah, is a notable exposure in which a thickness of 1,827 feet is exposed, the upper part of the formation, approximately 200 feet, being covered. In general, the formation is about 2,000 feet thick in this region.

D. STRATIGRAPHIC SECTION OF THE BRAZER LIMESTONE IN BLACKSMITH FOR CANYON. (T. 11 N., R. 2E.)

Nine Miles Southeast of Logan, Utah.

Number		Feet
22.	Concealed. (Shales and limestones in the Wellsville Range.)	200
21.	Dolomite, gray, banded with white calcite; thin bedded; outcrop irregular forming dip slope in many places and weathering grayish	25
20.	Limestone, bluish gray; contains chert nodules; thick bedded, but thin beds occur at irregular intervals; weathers dark gray; beds differ from each other in composition and texture. The whole forming a conspicuous ledge. Many fossiliferous members present	555
19.	Limestone, dark purplish gray, arenaceous; weathers light brown; sand grains show cross bedding on weathered surface; thin bedded. Near top lighter colored and thick bedded. Outcrop jagged. Contains cup corals	56
18.	Limestone, dark neutral gray, crystalline and argillaceous here and there; contains brown chert nodules; thin bedded with thick beds occurring at irregular intervals. Characterized by stylolites; weather light gray	20
17.	Siltstone, mouse gray, earthy; fractured outcrop forms jagged slope strewn with slabby, brown to pink talus; calcified and silicified cup coral present	145
16.	Limestone, mouse gray, arenaceous; sand shows cross bedding on weathered surface; contains chert nodules; thin bedded with bands of thick beds occurring at irregular intervals; fragments of crinoid stems present	36

Number		Feet
15.	Limestone, dark olive buff, arenaceous, upper 3′ almost quartzitic; amount of silica increases from base to top. Forms slopes in most places along outcrop	30
14.	Limestone, deep neutral gray, crystalline; upper and lower parts arenaceous; contains many fossil fragments, crinoid stems, and whole cup corals	60
13.	Siltstone, buffy brown, streaked with carbonaceous material; saccharoidal texture; thin and thick beds occur at irregular stratigraphic intervals; contains few sand grains larger than matrix; plant remains present	60
12.	Limestone, gray, dense; weathers light buff; contains cross bedded sand. Black flint occurs between beds. Upper 6 feet crystalline and thick bedded. Whole outcrop forms ledge. Fossil fragments and whole cup corals present	25
11.	Limestone, gray, highly crystalline; contains cross bedded sand that weathers buff. Fossil fragments and complete cup corals present	9
10.	Limestone, bluish black, weathers gray, arenaceous; contains chert layers and quartz geodes; sand abundant near top. Characterized by fragments of spirifers, Bryozoa and worm markings	400
9.	Limestone, deep neutral gray, saccharoidal; thick bedded except small unit in middle; outcrop highly fractured and deep olive gray, well exposed on steep slopes; contains small fragments of fossils	72
8.	Shale, drab, earthy; contains carbonaceous material, quartz grains, calcium carbonate, and other substances in minor quantities; beds thin and warped; fragments with concavo-convex faces	3½

Number		Feet
7.	Shale, hair brown, hard, weathers buffy brown, darkest near base; thick bedding with thin beds occurring at irregular intervals; forms slope with jagged outcrops obscured by angular fragments	49
6.	Limestone, blackish blue; contains irregularly bedded chert, fragments of fossil shells, and crinoid stems	3 ft. 2 in.
5.	Shale, bone brown, weathers drab; earthy, gritty	1 ft., 10 in.
4.	Limestone, bluish black, weathers gray; dense; contains nodular black flint; outcrop forms ledge; angular talus fragments; contains small cup coral	68
3.	Shale, drab, weathers buffy brown, harder than limestone, sandy near base, silty near top; here and there becomes fine grained sandstone	48
2.	Quartzite, deep olive buff, impure, medium sized grains (½ mm. diameter), fairly well sorted; contains calcite, carbonaceous material, and other substances in minor quantities; thick bedded, jointing almost at right angles to bedding plane; outcrop angular	96½
1.	Concealed, soil slope	50
0.	Shale, clove brown, phosphatic, carbonaceous; contains sub-angular blackish chert pebbles near base, lenticular masses of öolites throughout (largest 1 mm. in diameter); weathers olive brown; thin bedded, outcrop highly fractured, upper part concealed	15.
	Total	1,827

III. THE BRAZER FAUNA

A. COLLECTION; LOCALITIES

A stratigraphic reconnaissance of the Brazer in northern Utah has shown that the lower members contain few fossils, while the upper members are more fossiliferous.

The most abundant groups represented in the fauna are Brachiopoda, Pelecypoda, Anthozoa, Gastropoda, and Cephalopoda. For an introductory study the writer selected the telotremate Brachiopoda because of their value in correlation. Type and figured specimens, and a collection of Brazer fossils are deposited in the Geological Museum of the Utah State Agricultural College.

Fossils were collected from four localities in the Logan quadrangle:

Locality I.
Logan Canyon. At this locality the middle part of the formation is exposed.

Locality II.
Left Fork, Blacksmith Fork Canyon. At this locality, the most complete section was found.

Locality III.
Summit of the Wellsville Mountains near Spiers Ranch. The upper shales and limestones are exposed at this locality.

Locality IV.
One mile north of Dry Lake. Parts of the Upper and most of the Middle Brazer are exposed at this locality.

In Blacksmith Fork Canyon and in the Wellsville Mountains detailed sections were measured and each member was distinguished by its lithology. These members were numbered in succession beginning at the base of the formation, as shown in the detailed section. Members of similar stratigraphic position from different localities were given the same numbers. The members which are not exposed in the Blacksmith Fork section outcrop in localities I, III, and IV. As the Brazer-Wells boundary is not established, it is possible that the upper members from which collections were made are basal Wells.

B. TELOTREMATA OCCURRING IN THE BRAZER FORMATION AND EQUIVALENT FORMATIONS IN OTHER LOCALITIES.

BRAZER (Utah)	Amsden (Wyo.)	Chester (Ill.)	Ste. Genevieve (Mo.)	Maroon (Colo.)
Pugnoides uta				X ?
Pugnoides loganensis n. sp.				
Pugnoides tuberculatus n. sp.				
Pugnoides parvulus				
Dielasma sp.				X ?
Girtyella turgida		X		
Girtyella wellsvillensis n. sp.				
Girtyella brevilobata		X		
Spirifer pellaensis	X		X	
Spirifer leidyi		X		
Spirifer rockymontanus				X
Spirifer haydenianus				
Spirifer brazerianus				
Spirifer hammondi n. sp.				
Brachythyris utahensis n. sp.				
Ambocoelia girtyi n. sp.				
Syringothyris sp.?				
Martinia lata				
Martinia sp.				
Reticularia setigera		X		
Camarotoechia sp.?				
Cliothyridina hirsuta	X	X	X	
Composita farrelli n. sp.				
Composita trinuclea	X	X	X	

C. SYSTEMATIC PALEONTOLOGY

The species of Telotremata which had previously been described from the formation and were included in this investigation are *Pugnoides parvulus* Girty, *Girtyella turgida* (Hall), *Spirifer brazerianus* Girty, and *Martinia lata* Girty. The species figured in this paper are Telotremata previously not described from the Brazer. The synonymy listed is not complete, but the references selected gave detailed descriptions.

Genus PUGNOIDES Weller

Pugnoides uta (Marcou)

Plate XXVII, Figs. 1-4.

Terebratula uta Marcou, Geology of North America, p. 51, pl. 6, figs. 12-12c, 1850.

Description. — Dimensions of average specimen: length 17.3 mm., width 14.5 mm., height 10.6 mm. Shell outline in plane of valves subpentagonal, to subelliptical; outline of transverse cross section oval to subcircular. Pedicle valve with posterolateral margins nearly straight forming acute angle at beak; cardinal area indistinct; rather large delthyrium; foramen subcircular; beak incurved, acutely pointed, and extending beyond brachial valve. Convexity of brachial valve greater than that of pedicle. Sinus, fold and plications originate about one-third total length of shell in front of hingeline; sinus broad and moderately deep in front; fold moderately broad; plications decrease in size from middle front edge to lateral margins with four to six on each lateral slope of pedicle valve and two to four in sinus; brachial valve with four to six plications on each lateral slope and two to four on fold. Plications characterized by slight swells, linear curvatures, and size irregularities.

Remarks. — The larger size, irregular plications, and rather sharp anterior edge distinguish this species from *P. ottumwa*, and *P. osagensis*, although some paleontologists[6] have referred to *P. osagensis*, as a synonym of *P. uta*.

[6] Girty, G. H., U. S. Geol. Surv. Prof. Paper 16, pp. 412-413, 1903.

Girty[7] has suggested that *P. uta*, as described by Marcou is *P. triassicus*, but the latter is distinguished from *P. uta* by stronger convexity along the median line on the pedicle valve, broader sinus, higher fold, longer plications in the sinus, and symmetrical plications that increase in size and angularity toward the front margin.

Mathews[8] recently has listed *P. uta* from the Triassic of Utah, but in doing so he probably followed the suggestion of Girty.

The original description of *P. uta* was based upon a Carboniferous form, and the same species was redescribed by C. A. White[9] from the Utah Carboniferous. It is upon these descriptions, that the writer bases the present identification. Because of the priority of these descriptions, and the existence of differences between the Mississippian, Pennsylvanian, and Triassic *Pugnoides* the name *Pugnoides uta* should be restricted to the Upper Mississippian species.

Occurrence. — Brazer limestone, member 39, Wellsville Mountains, Utah.

Pugnoides loganensis Gunnell n. sp.

Plate XXVII, Figs. 5-8.

Description. — Dimensions of average specimen: length 14.3 mm., width 14 mm., height 6 mm. Shell outline in plane of valves subpentagonal to subelliptical, outline of transverse cross section, slightly in front of hingeline, oval. Pedicle valve with postero-lateral margins incurved to straight from beak to lateral margins, and forming obtuse angle at beak; no true cardinal area; delthyrium, rather large; foramen, subcircular; beak slightly incurved, acutely pointed, and extending beyond brachial valve. Pedicle valve almost flat in

[7] Girty, G. H., Appendix: U. S. Geol. Surv. Prof. Paper 152, pp. 434-435, 1927.

[8] Mathews, A. A. L., Mesozoic stratigraphy of the Central Wasatch Mountains, Oberlin College Lab. Bull. n. s. no. 1, p. 34, 1930.

[9] White, C. A., U. S. Geog. Surv. west of 100th Meridian, vol. 4, pp. 128-129, 1874.

umbonal region becoming concave about two-thirds total length of valve anterior to beak and maintaining concavity to front margin. Convexity of brachial valve almost uniform and stronger than that of pedicle. Sinus, fold, and plications originate slightly in front of hingeline; fold, broad and moderately high at front; sinus broad and rather deep at front; plications decrease in size from median line toward lateral margins, and increase in strength from point of origin to front margin, four to six plications occupy each lateral slope of pedicle valve with one to three in sinus; four to six plications occupy each lateral slope of brachial valve with two to four on fold.

Remarks. — Flat general shape and concavity of the pedicle valve distinguish this species.

Occurrence. — Brazer limestone, member 39, Wellsville Mountains, Utah.

Pugnoides tuberculatus Gunnell n. sp.

Plate XXVII, Figs. 9-12.

Description. — Dimensions of average specimen: length 15.6 mm., width 14.3 mm., height 6.7 mm. Shell outline in plane of valves subpentagonal, outline of transverse cross section oval to subcircular. Pedicle valve with postero-lateral margins nearly straight forming acute angle at beak, margins inflected toward beak to form false cardinal area; rather large triangular delthyrium; foramen subcircular; beak slightly incurved, acutely pointed, and extending beyond brachial valve; valve convex in umbonal region concave toward front; sinus broad and moderately deep at front; fold broad, and moderately higher at front; sinus, fold, and plications originate slightly in front of hingeline; plications increase in size from point of origin toward front and become angular, those on each side of sinus have developed longitudinal tubercules along frontal margin; number of plications on each lateral slope of pedicle valve four to six with one to three in sinus, three to six on each lateral slope of brachial valve, and two to four on fold.

Remarks. — Longitudinal tubercles on the anterior end

of the plications on each side of the sinus distinguish this species from *Pugnoides uta*.

Occurrence. — Brazer limestone, member 40, Wellsville Mountains, Utah.

Pugnoides parvulus Girty

Pugnoides parvulus Girty, Appendix. U. S. Geol. Surv. Prof. Paper 152, p. 414, pl. 23, figs. 34-44, 1927.

Remarks. — Typical specimens of this species occur in the "Blastoid zone" in Blacksmith Canyon. This species is small, and different specimens are rather uniform in size.

Occurrence. — Brazer limestone, Blastoid zone, member 20, Blacksmith Fork Canyon, Utah.

Genus DIELASMA King

Dielasma sp.

Plate XXVII, Figs. 13-15.

Remarks. — Two specimens of this species were collected at the "Blastoid zone" and smaller but similar specimens were collected from the Wells formation.

Occurrence. — Brazer limestone, member 20, Blacksmith Fork Canyon, Utah.

Genus GIRTYELLA Weller

Girtyella turgida (Hall)

Girtyella turgida (Hall) Girty, U. S. Geol. Surv. Prof. Paper 152, pl. 25, figs. 79-84, 1927.

Occurrence. — Brazer limestone, member 20, Blacksmith Fork Canyon, Utah.

Girtyella wellsvillensis Gunnell n. sp.

Plate XXVII, Figs. 18-21.

Description. — Dimensions of average specimen: length 13.6 mm., width 10.1 mm., height 12.5 mm. Shell outline, subpentagonal; outline of transverse cross section sub-

oval; width greatest at mid-length of shell, greatest height slightly more than one-third length of brachial valve in front of hingeline; convexity of valves strong; beak of pedicle valve strongly incurved, truncated by small round foramen. Surface of pedicle valve marked with small, mesial groove originating in umbonal region; anterior surface of both valves characterized by concentric growth lines. Internal structures well preserved; teeth supported by pair of strong dental plates extending anteriorly 5 mm. from beak.

Remarks. — This form is distinguished by the presence of a median septum in the brachial valve from *Cranaena occidentalis*, and from *Cirtyella breviloluta*, and *G. cedarensis*, by a more tapering elongate outline, smoother surface posteriorly, and smaller size.

Occurrence. — Brazer limestone, member 43, Wellsville Mountains, Utah.

Girtyella brevilobata (Swallow)

Plate XXVII, Figs. 16-17.

Terebratula brevilobata Swallow, Trans. St. Louis Acad. Sci., vol. 2, p. 84, 1863.

Girtyella brevilobata (Swallow) Weller, Ill. Geol. Surv., Mono. 1, p. 278, pl. 34, figs. 37-41, 1914.

Remarks. — One specimen of this species was found associated with *Girtyella wellsvillensis* n. sp. *Girtyella brevilobata* from the Chester is slightly less robust than the same species from the Brazer.

Occurrence. — Brazer limestone, member 44, Wellsville Mountains, Utah.

Genus SPIRIFER Sowerby

Spirifer pellaensis Weller

Plate XXVII, Fig. 28.

Spirifer pellaensis Weller, Ill. State Geol. Surv. Mono. 1, p. 340, pl. 45, figs. 1-31, 1914.

Remarks. — This species is very abundant at one hori-

zon, and the different specimens show many variations that are characteristic of the species.

Occurrence. — Brazer limestone, member 47, Wellsville Mountains, Utah.

Spirifer leidyi Norwood and Pratten

Plate XXVII, Fig. 25.

Spirifer leidyi Norwood and Pratten, Jour. Acad. Nat. Sci. Phil., (2), vol. 3, p. 72, pl. 9, figs. 2a-c, 1855.

Remarks. — This species is represented in the writer's collection by an incomplete pedicle valve.

Occurrence. — Brazer limestone, Blastoid zone, member 20, Blacksmith Fork Canyon, Utah.

Spirifer rockymontanus Marcou

Plate XXVII, Figs. 22-24.

Spirifer rockymontani (pars) Marcou, Geol. North America, p. 50, pl. 7, figs. 4c-4e, 1858.

Spirifer rockymontanus Marcou. Girty. The Carboniferous Formations and Faunas of Colorado: U. S. Geol. Surv. Prof. Paper 16, p. 383, pl. 16, figs. 4-7c, 1903.

Remarks. — Specimens of this species are distinguished from *Spirifer welleri* Branson, by the more tapering plications, and the slightly angular plications on *S. welleri* with rounding furrows between them.

Occurrence. — Brazer limestone, member 39, Wellsville Mountains, Utah.

Spirifer haydenianus Girty

Spirifer haydenianus Girty, Appendix: U. S. Geol. Surv. Prof. Paper 152, p. 416, pl. 24, figs. 18-21, 1914.

Occurrence. — Brazer limestone, member 43, Wellsville Mountains, Utah.

Spirifer brazerianus Girty

Spirifer brazerianus Girty, Appendix: U. S. Geol. Surv. Prof. Paper 152, p. 416, pl. 24, figs. 12-17, 1927.

Remarks. — Specimens of this species occur with Wells and Brazer fossils.

Occurrence. — Member 47, Wellsville Mountains, Utah.

Spirifer multistriatus Gunnell n. sp.

Plate XXVII, Figs. 46, 49.

Description. — Dimensions of average specimen: length 32.1 mm., width 58 mm., height 13.5 mm. Shell outline in plane of valves semielliptical; outline of longitudinal cross section subelliptical; width greatest along hingeline; greatest height at mid-length of shell. Pedicle valve more convex than brachial with greatest convexity in umbonal region; surface flat toward cardinal extremities; beak slightly extended beyond hingeline. Brachial valve rather uniformly convex. Neither fold or sinus present. Surfaces of valves marked by fine radiating striae which bifurcate; striae crossed by faint growth lines; growth lines more strongly developed on brachial valve; striae number 3 to 2 mm., at front margin, total on pedicle valve about 96.

Remarks. — The absence of a fold and sinus distinguishes this species from *Spirifer tenuicostatus*.

Occurrence. — Brazer limestone, member 43, Wellsville Mountains, Utah.

Spirifer hammondi Gunnell n. sp.

Plate XXVII, Figs. 26, 27.

Description. — Dimensions of pedicle valve: length 13.7 mm., width 23.3 mm., height 5.8 mm. Outline of pedicle valve subsemicircular; valve strongly convex, median line describes almost semicircle with greatest curvature at posterior portion; umbo incurved and extended beyond hingeline; lateral slopes gently convex from median line to lateral margins; mesial sinus originates near beak and widens slightly toward front, contains three indistinct plications. Surface of pedicle valve marked with about sixteen rounded plications on each lateral slope, and faint growth lines on anterior part.

Remarks. — This specimen closely resembles *S. centron-*

atus, but is more inflated in umbonal region, and has a less tapering sinus.

Occurrence. — Brazer limestone, member 20, Blacksmith Fork Canyon, Utah.

Genus BRACHYTHYRIS McCoy

Brachythyris utahensis Gunnell n. sp.

Plate XXVII, Figs. 29-31.

Description. — Dimensions of incomplete pedicle valve: length 20.5 mm., width 19.7 mm., height 10 mm. Outline of pedicle valve subcordiform with apex at beak; width greatest mid-way between hingeline and anterior margin, height greatest mid-way between posterior and anterior extremities; convexity strong and rather uniform; umbo extending far beyond hingeline; beak slightly incurved over cardinal area; cardinal area arched, and marked with fine striae at right angles to hingeline; delthyrium large and extending into beak; each lateral slope marked by seven radiating, angular plications which gradually increase in size from posterior to anterior and from lateral margins toward mesial sinus; mesial sinus well defined, and occupied by one plication.

Remarks. — The subcordiform outline, hingeline shorter than, and posterior to greatest width of pedicle valve distinguishes this species from other species of *Brachythyris*.

Occurrence. — Brazer limestone, Blastoid zone, member 20, Wellsville Mountains, Utah.

Genus AMBOCOELIA Hall

Ambocoelia girtyi Gunnell n. sp.

Plate XXVII, Figs. 33-35.

Description. — Dimensions of average specimen: length 14 mm., width 16.2 mm., height 8.2 mm. Shell outline in plane of valves subelliptical, width greatest near midlength of shell; greatest height slightly in front of hingeline. Pedicle valve strongly convex, greatest convexity posterior to middle; umbo prominent; beak projecting 4 mm. beyond hinge-

line, prominent, pointed, and incurved; cardinal area small and strongly arched; delthyrium narrow and triangular. Brachial valve less convex than pedicle, greatest convexity posterior to middle curving abruptly toward cardinal margin and gently sloping toward front. Shallow mesial sinus present on pedicle valve in some forms, otherwise surface of both valves smooth. Most forms not bilaterally symmetrical.

Remarks. — The exterior of this species closely resembles *Squamularia perplexa*.

Occurrence. — Brazer limestone, number 46, Wellsville Mountains, Utah.

Genus SYRINGOTHYRIS Winchell

Syringothyris sp.?

Plate XXVII, Fig. 32.

Description. — Length of valve 62 mm.; outline, subquadrate; convexity slight. Sinus large, rounding, originating at beak, and extending to front margin; width of sinus at front margin 25 mm. Surface marked with radiating costae, width of one costae at front margin 3.5 mm.; concentric growth lines increase in distance apart from anterior to posterior.

Remarks. — This specimen is an incomplete pedicle valve that resembles a *Syringothyris* but a syrinx cannot be made out.

Occurrence. — Brazer limestone, member 17, Logan Canyon, Utah.

Genus MARTINIA McCoy

Martinia lata Girty

Martinia lata Girty, Appendix: U. S. Geol. Surv. Prof. Paper 152, p. 417, pl. 24, figs. 1-7, 1927.

Occurrence. — Brazer limestone, member 17, Logan Canyon, Utah.

Martinia sp.
Plate XXVII, Fig. 36.

Description. — Dimensions of complete pedicle valve: length 18.6 mm., width 25 mm., height 9.4 mm. Shell outline of pedicle valves subelliptical; width greatest midway between posterior and anterior margins; height greatest at right angles to hingeline and plane of valve; greatest convexity in umbonal region, convexity gradually decreases toward lateral and anterior margins; cardinal area arched, small, and ill defined; delthyrium, triangular; beak pointed, and strongly incurved. Surface marked by a few indistinct concentric growth lines, and shallow rounding mesial sinus that originates in umbonal region and extends to anterior margin.

Remarks. — This species is distinguished from *Martinia contracta* by the greater width to length ratio and from *M. sulcata*, by the absence of surface markings.

Occurrence. — Brazer limestone, member 20, Blacksmith Fork Canyon, Utah.

Genus RETICULARIA McCoy
Reticularia setigera (Hall)
Plate XXVII, Figs. 37, 38.

Reticularia setigera Weller, Ill. Geol. Surv. Mon. I, p. 431, pl. 74, figs. 12-22, 1914.

Remarks. — Specimens of this species are represented in the collection by several pedicle valves that show no marked difference from the Chester species of the Mississippi Valley.

Occurrence. — Brazer limestone, member 41, Wellsville Mountains, Utah.

Genus CAMAROTOECHIA Hall and Clarke
Camarotoechia sp.?
Plate XXVII, Figs. 39, 40.

Occurrence. — Brazer limestone, member 20, Wellsville Mountains, Utah.

Genus CLIOTHYRIDINA Buckman
Cliothyridina hirsuta Hall
Plate XXVII, Figs. 41-43.

Cliothyridina hirsuta Weller. Ill. Geol. Surv. Mono. 1, p. 479, pl. 80, figs. 13-24, 1914.

Remarks. — These specimens are larger than those of the same species described by Weller, but in other characteristics they are similar. This species occurs at the horizon where most of the fossils of a Ste. Genevieve facies are found.

Occurrence. — Brazer limestone, member 39, Wellsville Mountains, Utah.

Genus COMPOSITA Brown

Composita trinuclea Hall

Plate XXVII, Fig. 44.

Terebratula trinuclea Hall, Trans. Albany Inst., vol. 4, p. 7, 1856.
Composita trinuclea Weller, Ill. Geol. Surv. Mono. 1, pp. 486-488, pl. 81, figs. 46-51, 1914.

Remarks. — Specimens of this species show many variations as do those of the Mississippi Valley.

Occurrence. — Brazer limestone, member 35, Wellsville Mountains, Utah.

Composita farrelli Gunnell n. sp.

Plate XXVII, Figs. 45-47.

Description. — Dimensions of average specimen: length 14.3 mm., width 14.2 mm., height 9.8 mm. Shell outline in plane of valves subpentagonal, postero-lateral margins straight forming almost right angle at beak; beaks of both valves prominent; that of pedicle valve pointed, incurved, and projecting beyond that of brachial; foramen very small; mesial sinus rounded, originating in umbonal region and gradually increasing in size outward. Surfaces of both valves smooth, gradually increasing in convexity from front and lateral margins toward beaks. Internal structures well developed; in some forms faint median septum occurs in brachial valve.

Remarks. — This form is readily distinguished from *Composita subquadrata*, by the absence of a fold on the brachial valve.

Occurrence. — Brazer limestone, member 39, Wellsville Mountains, Utah.

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COLUMBIA, MISSOURI.

PLATE XXVII.

Figures

1–4. *Pugnoides uta* (Marcou)
Pedicle, brachial, posterior, and lateral views of an average specimen.

5–8. *Pugnoides loganensis* Gunnell, n. sp.
Pedicle, brachial, front, and lateral views of an average specimen.

9–12. *Pugnoides tuberculatus* Gunnell, n. sp.
Pedicle, brachial, posterior, and lateral views of an average specimen.

13–15. *Dielasma* sp.
Pedicle, brachial, and lateral views.

16–17. *Girtyella brevilobata* (Swallow)
Pedicle, and lateral views.

18–21. *Girtyella wellsvillensis* Gunnell, n. sp.
Pedicle, brachial, lateral, and posterior views.

22–24. *Spirifer rockymontanus* Marcou.
Pedicle, brachial, and lateral views of a small specimen.

25. *Spirifer leidyi* Norwood and Pratten.
Pedicle view of an incomplete pedicle valve.

26–27. *Spirifer hammondi* Gunnell, n. sp.
Pedicle, and lateral views of a brachial valve.

28. *Spirifer pellaensis* Weller.
Pedicle view of an incomplete pedicle valve.

29–31. *Brachythyris utahensis* Gunnell, n. sp.
Pedicle, cardinal, and lateral views of a pedicle valve.

32. *Syringothyris* sp.?
Pedicle view one-half natural size.

33–35. *Ambocoelia girtyi*, Gunnell, n. sp.
Pedicle, brachial, and lateral views of an average specimen.

36. *Martinia* sp.
Pedicle view one-half natural size.

37–38. *Reticularia setigera* Hall.
Pedicle, and lateral views of a complete pedicle valve.

39-40. *Camarotoechia* sp.?
Pedicle, and front views of an incomplete specimen.

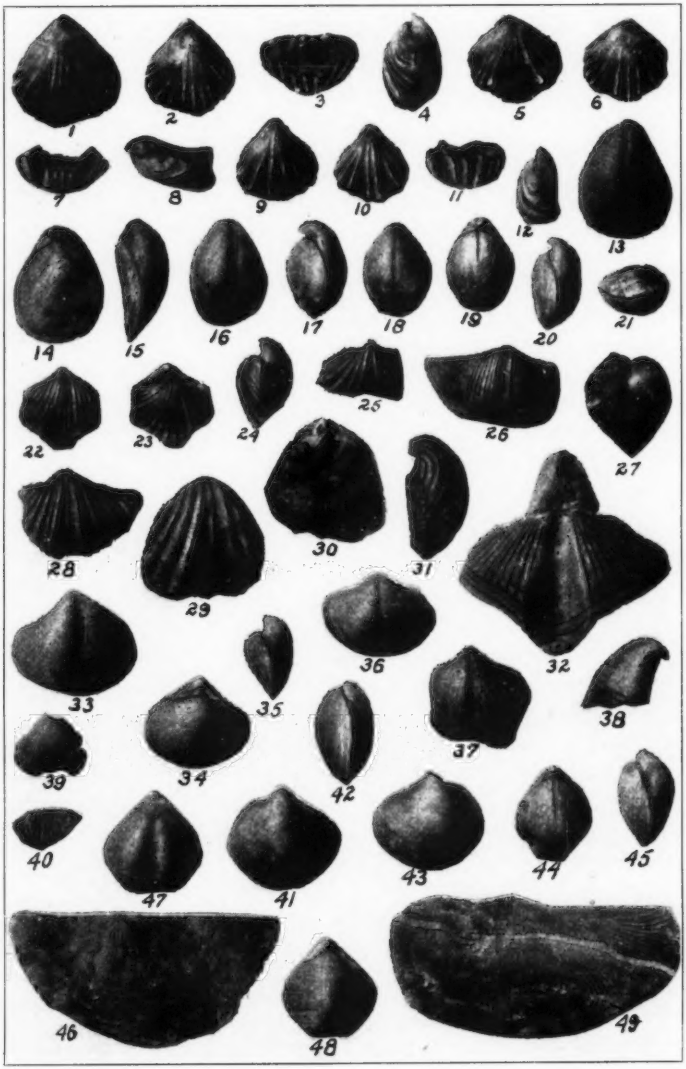
41–43. *Cleiothyridina hirsuta* Hall.
Pedicle, brachial, and lateral views of a complete specimen.

44. *Composita trinuclea* (Hall).
Brachial view of a complete specimen.

45, 47, 48. *Composita farrelli* Gunnell, n. sp.
Pedicle, brachial, and lateral views of an average specimen.

46, 49. *Spirifer multistriatus* Gunnell, n. sp.
Pedicle, and brachial views of an average specimen.

PLATE XXVII.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SEXUAL DIMORPHISM IN FOSSIL OSTRACODA

C. I. ALEXANDER

The literature on Recent Ostracoda contains many references to the occurrence of sexual dimorphism among the living representatives of the order. Cretaceous and Tertiary Ostracoda are, perhaps without exception, referable to genera which are represented by species living in the seas today. It is remarkable, therefore, that sexual dimorphism has only recently been described in fossil members of the same families and genera in which students of the Recent species have recognized the phenomenon for some time.

In many genera of the Ostracoda, the dimorphism is so slight that it is impossible to differentiate male and female specimens from a study of the shell alone. In others, however, the sexes are readily distinguished by pronounced difference in the form of the carapace.

The members of the family Cytherellidae exhibit the most marked dimorphism. The carapace of the female is usually slightly larger than that of the male, and is proportionately higher and broader, especially near the posterior end. Within the space afforded by the inflated posterior region of the shell, the eggs and the developing embryos are carried and protected.

Van Veen[1] was the first student to point out these differences in a fossil ostracod of Cretaceous or Tertiary age, describing and figuring male and female carapaces of members of the genus *Cytherelloidea*. The differences which characterize the shells of males and females of the Recent species *C. abyssorum* (Sars) were described and illustrated, and specimens of the Cretaceous species *C. denticulata* (Bosquet) were then shown to exhibit the same two shell types.

Alexander[2], in 1929, described two species of the genus

[1] Van Veen, J. E., Vorlaüfig Mitteilung über die *Cytherella*-Arten der Maastrichter Tuffkreide, Naturrhist. Maand., Jahrg. 17, No. 9, pp. 123-125, 1928.

[2] Alexander, C. I., Ostracoda of the Cretaceous of North Texas, Univ. of Texas Bull. No. 2907, pp. 73-74, 1929.

Cytheridea (family Cytheridae) as exhibiting "two shell types, one of which is somewhat more globose, both in lateral and in dorsal view than the other," and attributed the differences to sexual dimorphism. The more globose forms were described as "probably the females." In the same paper, however, the writer failed to recognize several cases of sexual dimorphism among members of the genus *Cytherella*, the males and females being described as separate species. This error is, indeed, a common one in literature on the Cretaceous and Tertiary Ostracoda.

In preparing the present paper, the writer has had a twofold object: first, to correct the errors which appeared in his earlier paper, referred to above, by recognizing some of the forms originally described under separate specific names as male and female of the same species, and second, to indicate, by means of careful descriptions and figures, the features which distinguish the shells of males and females of several characteristic species of *Cytherella*, as an aid to other students of the fossil Ostracoda in correctly assigning their specimens.

Since the contour of the shells is the feature of greatest importance, both in the recognition of male and female specimens and in the differentiation of species, and since the surface of all the forms illustrated is smooth and without sculpturing of any kind, the figures have been drawn in outline only.

DESCRIPTION OF SPECIES

Cytherella ovata (Römer)

Plate XXVIII, Figs. 1, 2.

Cytherina ovata Römer, 1840, Verstein. norddeutsch. Kreidegeb., p. 104, pl. 16, fig. 21.

Cytherella ovata Jones, 1849, Monogr. Cret. Entom. England, Paleontogr. Soc. London, p. 28, pl. 7, figs. 24a-i.

Cytherella ovata Jones and Hinde, 1890, Suppl. Monogr. Cret. Entom. England and Ireland, Paleontogr. Soc. London, p. 44, pl. 3, figs. 48-54, pl. 4, fig. 39.

Cytherella obovata Jones and Hinde, 1890, Idem., p. 46, pl. 3, figs. 46, 47.

Cytherella navarroensis Alexander, 1929, Univ. of Texas Bull. No. 2907, p. 53, pl. 2, figs. 1, 2.

Cytherella moremani Alexander, 1929, Idem., p. 53, pl. 1, figs. 4, 5.

Description.— Carapace of female ovate, of male, oblong-ovate, in side view. Dorsal margin arched, highest, and obscurely angled at or slightly anterior to middle, with short, rather flat slope toward anterior end and with longer, slightly steeper and somewhat more curved posterior slope; the dorsal margin of the female is more strongly arched than that of the male. Ventral margin gently and evenly convex, that of the male being almost straight. Anterior end broadly and evenly rounded. Posterior end low, narrower than anterior, and somewhat obliquely rounded. Right valve larger than left, and overlapping it around entire margin; overlap strongest along anterior half of dorsal margin, decreasing abruptly just behind the obscure angle at the middle of the margin, and along the ventral border. In dorsal view, carapace of female elongate-ovate, widest slightly behind middle, sides of carapace sloping flatly toward each end from point of maximum width, with anterior end subacute and posterior slightly blunter; carapace of male similar in outline, but more compressed than that of female.

Measurements of plesiotypes: female, length 0.9 mm., height 0.6 mm., width, 0.4 mm.; male, length, 0.88 mm., height, 0.55 mm., width, 0.34 mm.

Römer described *C. ovata* from the *"Chalk-marl"* of Lemförde. The occurrence of *Bostrychoceras polyplocum* (Römer), *Belemnitella mucronata* (Schlötheim), and other well-known, horizon-marking macrofossils in these strata indicates that they are of upper Senonian age.[3] Jones, in 1849, described the species as occurring in the English "Chalk," and the localities at which his collections of "Chalk" were made afforded exposures of approximately the same stratigraphic level as Römer's type locality in northern Germany. Jones and Hinde, in 1890, in their "Introduction," describe these localities and the stratigraphic position of the various exposures. Jones also states, p. 28, that *C. ovata* occurs "in all the Cretaceous deposits, except the Speeton clay; it occurs also in a Tertiary Blue Clay at Bracklesham." Obviously, Jones regarded every member of the genus *Cytherella* having

[3] Schlüter, C., Cephalopoden der oberen deutschen Kreide, vol. 2, pp. 247-248, 1876.

an ovate outline as *C. ovata*. The present writer has indicated in his "Ostracoda of the Cretaceous of North Texas," several features of shell structure which are useful in making species distinctions in this genus.[4] The most important are, (1) the amount by which the right valve overlaps the left at different points along the periphery, and (2) the appearance of the shell in dorsal view. While many ovate forms, more-or-less closely resembling *C. ovata* do occur throughout the Cretaceous strata, they are readily recognizable as distinct species by means of these criteria.

Jones and Hinde, 1890, described the new species, *C. obovata*, from the "Chalk," at Kent. It is the writer's belief that this form is the male of *C. ovata*.

The two species, *C. navarroensis* and *C. moremani*, described by Alexander in 1929, occur in the Navarro formation in Texas, and in equivalent formations in neighboring regions. This stratigraphic level of the American Upper Cretaceous is correlative with the upper Senonian of Europe. *C. navarroensis* is here recognized as the male, and *C. moremani* as the female of Römer's *C. ovata*.

The form identified as *C. ovata* by Alexander, from the Goodland and Kiamichi formations of Texas[5] is a separate and distinct species, and thus lacks a specific name. In the above reference, only the female form was described and figured. Both male and female are described, on a later page, under a new specific name.

Plesiotypes. — Female, No. O-2440.1; male, No. O-2440.2 Alexander Collections, collected at an exposure of Navarro clays in an abandoned clay pit, 2 miles south of Corsicana, Texas.

Cytherella bullata Alexander

Plate XXVIII, Figs. 3, 4.

Cytherella obesa Alexander, 1929, (non *C. obesa* Jones, Kirkby and Brady, 1884) Univ. of Texas Bull. No. 2907, p. 51, pl. 1, figs. 3, 6.
Cytherella austinensis Alexander, 1929, Idem., p. 51, pl. 2, figs. 4, 6.
Cytherella bullata Alexander, 1931, Jour. Pal., vol. 6, p. 101.

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[4] Alexander, C. I., l. c., p. 47.
[5] Alexander, C. I., l. c., p. 47, pl. 1, figs. 1, 2.

D e s c r i p t i o n . — Carapace of female ovate, of male, elongate-ovate, in side view. Dorsal margin arched, highest, and obscurely angled at middle. Ventral margin of female gently convex, of male, slightly convex, almost straight. Anterior end broadly and evenly rounded. Posterior end lower and narrower than anterior, obliquely rounded; in male, lower and narrower than in female. Right valve larger than left and overlapping around entire periphery of shell; amount of overlap moderate and almost uniform except at postero-ventral angle, where it is much less than elsewhere. In dorsal view, valves of female strongly convex, widest near posterior end, anterior end subacute, posterior broad, bluntly rounded; valves of male more compressed, widest slightly posterior to middle, and with posterior end but slightly blunter than anterior.

Measurements of plesiotypes: female, length, 0.84 mm., height 0.55 mm., width 0.38 mm.; male, length 0.78 mm., height 0.46 mm., width 0.3 mm.

This species, like all the other ovate types of *Cytherella*, bears a strong superficial resemblance to *C. ovata*, but is readily differentiated by (1) the marked difference in the curvature of the dorsal margin, (2) the equally marked difference in the amount by which the right valve overlaps the left, and (3) the even more pronounced differences in the appearance of the shell, especially in the case of the female, in dorsal view.

The form described as *C. austinensis* in 1929 is undoubtedly the male and the form described as *C. obesa* the female of the same species. The latter name has page precedent, but was preoccupied by *C. obesa* Jones, Kirkby and Brady, 1884. The new name, *C. bullata*, was later proposed for the Texas Cretaceous species.

This species ranges from the upper Austin chalk formation to the top of the Pecan Gap chalk member of the Taylor formation, in north Texas, through the equivalent upper Austin and lower Taylor strata of south Texas, and occurs in the Brownstown marl and in the Gober and Annona chalks of the northeastern portion of the state. The specimens from the

Brownstown are characteristically larger than those from the chalk formations, but are otherwise exactly similar.

Plesiotypes. — Female, No. O-2442.1; male, No. O-2442.2 Alexander Collections, from the type locality for the species, an exposure of upper Austin chalk in the bank of a small gully a few feet west of a concrete culvert on the Dallas-Garland highway, at a point 3.4 miles northeast of White Rock dam.

Cytherella comanchensis Alexander

Plate XXVIII, Figs. 5, 6.

Cytherella comanchensis Alexander, 1929, Univ. Texas Bull. No. 2907, p. 49, pl. 1, figs. 7, 8.

Cytherella obovata Alexander, 1929, (non *C. obovata* Jones and Hinde, 1890) Idem., p. 49, pl. 2, figs. 5, 9.

Description.—Carapace in side view elongate, quadrate in outline. Dorsal and ventral margins almost straight and parallel; dorsal very slightly convex, ventral gently sinuate slightly behind middle, gently convex near ends. Anterior end broadly and evenly rounded. Posterior end obliquely rounded, lower and narrower than anterior, especially in male. Right valve overlapping left around entire margin; in female, overlap is stronger along anterior portion of dorsal and ventral margins than elsewhere. In dorsal view, carapace of female widest at posterior end, anterior end subacute, posterior roundly truncated; carapace of male with valves gently and evenly convex, anterior end acute, posterior bluntly rounded.

Measurements of plesiotypes: female, length 0.63 mm., height 0.36 mm., width 0.29 mm.; male, length 0.63 mm., height 0.36 mm., width 0.25 mm.

C. comanchensis ranges through the Lower Cretaceous formations of north Texas, from Fort Worth to Grayson, inclusive, and through the equivalent strata of the Georgetown and in the Del Rio of south Texas. The species is usually rare in the lower portion of its stratigraphic range, increases in abundance upward, and is most common in the Grayson clays.

The form identified as *C. obovata* Jones and Hinde by

Alexander in 1929 is now recognized as the male of *C. comanchensis*.

Plesiotypes. — Female, No. O-2302.1; male, No. O-2302.2 Alexander Collections, from type locality for the species, an exposure of the Grayson clays in a high bluff on the north bank of Denton Creek, about 4 miles northeast of Roanoke, Denton County, Texas.

Cytherella fredericksburgensis n. sp.

Plate XXVIII, Figs. 7, 8.

Cytherella ovata Alexander, 1929, (non *C. ovata* Römer, 1840) Univ. Texas Bull. No. 2907, p. 47, pl. 1, figs. 1, 2.

Description. — The male of this species is almost exactly similar, in side view, to the male of *C. bullata*, described earlier in this paper. The two are readily distinguished, however, when examined in dorsal view; the sides of the valves in the present species are more nearly straight and parallel, and the anterior end is much blunter than in *C. bullata*.

The female is similar in appearance to the female of *C. ovata*, but differs in a number of important features; (1) the dorsal margin is more strongly arched, is highest and obscurely angled behind, rather than in front of the middle, and has a long, flat slope toward the anterior end and a shorter, steeper, and more curved slope toward the posterior end, (2) the posterior end is but slightly, rather than distinctly, narrower than the anterior, (3) the right valve overlaps the left almost as strongly along the posterior half of the dorsal margin as along the anterior half, and (4) in dorsal view, the sides of the valves are strongly convex, rather than sloping flatly toward each end from the point of greatest width, and the ends of the carapace are much blunter than in *C. ovata*.

Measurements of cotypes: female, length 0.82 mm., height 0.57 mm., width 0.42 mm.; male, length 0.82 mm., height 0.46 mm., width 0.3 mm.

This species has been found only in the Fredericksburg Division of the Lower Cretaceous of Texas, and is most abundant in the upper two-thirds of the Goodland formation.

Cotypes. — Female, No. O-2301.1, and male, No. O-2301.2 Alexander Collections, collected at an exposure of upper Goodland, at Cragin Knobs, on the Stove Foundry road, 3 miles west of the new Texas and Pacific Railroad shops in Fort Worth.

Cytherella paenovata n. sp.

Plate XXVIII, Fig. 9.

Description. — Carapace in side view almost perfectly oval in outline. Dorsal margin strongly arched, highest at middle, with flat slope toward anterior end and rounded slope toward posterior end, from highest point of margin. Ventral margin strongly convex. Anterior and posterior ends similar, broadly and evenly rounded. Right valve overlaps left around entire margin of shell; overlap strongest along middle of dorsal and ventral margins, also distinctly stronger at middle of anterior and posterior margins than at antero-dorsal, antero-ventral, postero-dorsal and postero-ventral angles. Carapace in dorsal view strongly convex, widest slightly behind middle; sides of valves slope flatly toward anterior end, which is narrow and subacute, posterior end blunt, rounded.

Length of holotype 0.8 mm., height 0.55 mm., width 0.42 mm. The holotype is a female specimen. No males of this species have been found.

C. paenovata occurs as a rare species in the Taylor formation in Texas. It is of interest chiefly because only female specimens have been found. Van Veen[6] describes the same phenomenon, stating that she has been able to differentiate as many as fifteen species of *Cytherella* from the Upper Cretaceous strata of Limbourg, and that in most cases, males as well as females have been found. In referring to the fact that diligent search failed to reveal the males of some of the species, she says that "it is entirely possible to find females alone, as has been observed in the case of some Recent species of the Ostracoda."

Many Ostracoda, as well as other marine and fresh-water

[6] Van Veen, J. E., l. c., p. 125.

Entomostraca, are known to reproduce parthenogenetically. Males are produced only at intervals, at which times sexual reproduction takes place; several successive generations of females may then be produced without the intervention of males. Some Entomostraca are believed to exhibit the phenomenon of thelytokous reproduction. Males are unknown, and parthenogenetic reproduction by successive generations of females apparently proceeds uninterruptedly.

Holotype.—No. O-2441.1 Alexander Collections, collected at an exposure of lower Taylor clays in the north bank of Opossum Creek, about 300 feet east of the Waco-Taylor highway, at a point two miles southwest of Granger, Williamson County, Texas.

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FORT WORTH, TEXAS.

PLATE XXVIII.

Figures

1, 2. *Cytherella ovata* (Römer); fig. 1, female, a, left valve view, b. dorsal view; fig. 2, male, a, left valve view, b, dorsal view.

3, 4. *Cytherella bullata* Alexander; fig. 3, female, a, left valve view, b, dorsal view; fig. 4, male, a, left valve view, b, dorsal view.

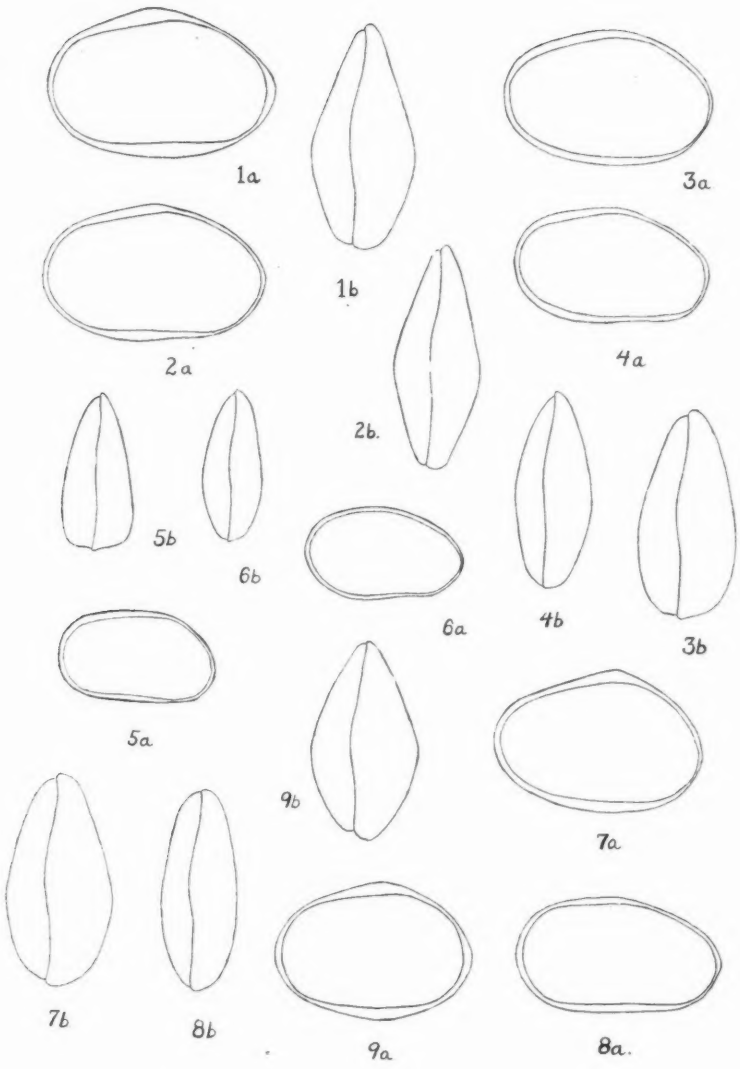
5, 6. *Cytherella comanchensis* Alexander; fig. 5, female, a, left valve view, b, dorsal view; fig. 6, male, a, left valve view, b, dorsal view.

7, 8. *Cytherella fredericksburgensis* Alexander, n. sp.; fig. 7, female, a, left valve view, b, dorsal view; fig. 8, male, a, left valve view, b, dorsal view.

9. *Cytherella paenovata* Alexander, n. sp.; a, left valve view, b, dorsal view.

All figures x 38.

PLATE XXVIII.



FOSSIL FORAMINIFERA FROM THE CRETACEOUS, RIPLEY FORMATION, OF ALABAMA

JOHN R. SANDIDGE

The foraminiferal fauna of the Ripley has many interesting and striking relationships with faunas from other localities. The presence of an appreciable number of species now living in the Gulf of Mexico and the Caribbean Sea is significant, as also is the large proportion of Mediterranean species from the Cretaceous of Europe. The occurrence of these fossils in the Ripley is interpreted as substantiating the inference that the Ripley sea was moderately warm, or warm-temperate, and shallow. Very close relationships with neighboring fossil faunas may be traced, especially with those in the western part of the Gulf Embayment. The Navarro formation of Texas has been found to have a large number of species in common with the Ripley, and farther southwest in the Velasco shale of Mexico there also is a good representation of common forms. The Tertiary of the Gulf Coast and of the Atlantic Coastal Plain contains many species which range upward from the Cretaceous, but they are commopolitan forms and have no particular significance in establishing stratigraphic relationships.

There is no published work giving complete information regarding the foraminiferal fauna of the Navarro formation of Texas, but lists of species compiled by micropaleontologists of the Southwest furnish reliable means of making comparisons with the Ripley. They reveal at least 27 identical species and 24 common genera. One of the most conspicuous forms occurring in the two formations is *Clavulina insignis*. This is a well preserved and easily recognized test which is very useful for identifying these formations. *Rotalia cretacea*, occurring frequently in the upper beds of the Ripley, and reported to be amundant in the Navarro, is another particularly valuable form for establishing the relationships between the two formations. Perhaps the most striking of all the common species are the two *Flabellinas*, *F. rugosa*, and *F. interpuncta*. They are remarkably well preserved and easily

identified forms which abound in both Ripley and Navarro beds, and suggest an unmistakable relationship between these deposits. Other significant species common to both formations are *Dorothia bulleta*, *Dentalina crinita*, *Ventilabrella carseyae*, *Loxostoma plaitum*, *Globotruncana arca*, *G. fornicata*, *Anomalina taylorensis*, and *Nodosaria alternata*. To say that the Ripley and the Navarro are synchronous would be premature, but evidence based on the macro-fossils, as well as the micro-organisms, suggests that they surely are not of greatly different ages.

No work has been done on the lower Eocene foraminifera of Alabama, and consequently the relationships between them and the Ripley fauna can not be shown at this time. Comparison of the forms with those of the Texas Midway is interesting but holds no particular significance. Mrs. Plummer[1] lists 103 species and 31 genera of foraminifera from this formation. Eighteen of the species are identical with Ripley forms, and twenty genera are common to the two formations. The identical forms are with few exceptions cosmopolitan types, many of which are living today, and are of little value in determining the late Cretaceous and early Eocene relationships. Contributions to the solution of this problem must await further study of the Selma chalk and Ripley foraminifera, as well as those of the Clayton limestone and Sucarnochee clay.

The large and interesting foraminiferal fauna of the Ripley formation contains numerous species which have not been recorded in scientific literature. Four of these new species are presented in the following descriptions.

DESCRIPTION OF SPECIES

Family LAGENIDAE

Genus ROBULUS Montfort, 1808

Robulus alexanderi, n. sp.

Plate XXIX, figs. 1, 2.

Test close-coiled, strongly convex, peripheral margin subacute; apertural face triangular, slightly impressed; cham-

1 Plummer, Helen Jeanne, "Foraminifera of the Midway Formation in Texas," Univ. of Texas, Bull 2644, 1926.

bers few, eight in number; sutures indistinct in early stages, very slightly raised between last few chambers, gracefully curving away from aperture, earlier apertures partially visible at periphery; wall smooth; aperture at the peripheral angle, radiate, with lower part extending as a slit into the apertural face. Diameter of holotype, 0.7 mm.

The chief importance attached to this form is its ease of recognition, and possible value as a guide fossil. *Robulus alexanderi* resembles *Lenticulina ovalis* reported by Reuss[1] from the Planers, but differs from Reuss' figures in having a robuline aperture. The species is named for Dr. C. I. Alexander, Professor of Paleontology at Texas Christian University, Fort Worth, Texas.

This species has been found ranging through the entire Ripley of the Alabama-Tombigbee River section.

The holotype is from Barton's Bluff, on the Tombigbee River (Locality No. 53). This is situated about 8 miles above Moscow on the Tombigbee River where there is an exposure of some 60 feet in which both the Selma chalk and Ripley occur. This is a fault zone, where vertical displacement has brought the chalk and sandy facies into juxtaposition. The Ripley at this point is highly calcareous, but presents the usual sandy, glauconitic aspect, and is very similar to the exposure at Boguechitto Creek. It contains a very rich foraminiferal fauna.

Genus FRONDICULARIA Defrance, 1824

Frondicularia berryi n. sp.

Plate XXIX, figs. 2, 3.

Test elongate, slender, much compressed, flat, constricted near the middle, later portion somewhat wider than early part, angles slightly carinate, border concave; initial chamber globular, bearing a short apical spine, the first succeeding chambers have the appearance of short chevrons, in later stages becoming longer, wider, and the apical angles more

1 Reuss, Paleontographica, vol. 20, pt. 2, 1871-1875, p. 103, pl. 22, figs. 6-11.

acute; sutures forming elevated ridges of clear shell material, prominent near the axis of the test and becoming indistinct at the margin, conforming to the contours of the chambers; wall smooth; aperture terminal, slightly produced, round; earlier apertures visible through the shell wall as narrow tubes connecting the successive chambers. Length of holotype, 2.8 mm.

This striking shell in unimneralized and almost perfectly preserved. It resembles *F. goldfussi* Reuss in the character of the border and the arrangement of the chambers, especially in the early stages. The outline of the test is quite different, however, resembling in this characteristic *F. augustissima*, another of Reuss early species. The peculiar constriction of the test near the middle is a most striking feature, not shown by any other known species, which makes differentiation of this form comparatively simple. The species has been named for Professor Edward W. Berry, Professor of Paleontology at John Hopkins University.

F. berryi is very rare, and has been found in the lower strata of the Ripley formation only at Barton's Bluff, on the Tombigbee River (Locality No. 53), described in the discussion of *Robulus alexanderi* n. sp.

Family CASSIDULINIDAE

Genus PULVINULINELLA Cushman, 1926

Pulvinulinella ripleyensis n. sp.

Plate XXIX, figs. 12-14.

Test biconvex, conical on ventral side, a small umbilical knob at the apex, slightly rounded on dorsal side, peripheral margin acute, not flanged; chambers numerous, five in last whorl; wall smooth; sutures distinct, flush, visible as fine dark lines; on dorsal side spiral suture coils toward proloculum at center of test, transverse sutures crossing whorls as short curved lines bending contrary to the direction of coiling; on ventral side transverse sutures extend from central apex to margin, curving away from the apertural faces of the chambers; aperture a narrow slit on the ventral side at the base

of the last-formed chamber, near the periphery, parallel to the plane of coiling. Diameter of the holotype, 0.15 mm.

This species has been found frequently in the Ripley of Central Alabama. It is also encountered by Mrs. Plummer[1] in the lower beds of the Navarro formation of Texas. The form is extremely small, and for this reason it is not as valuable as an index fossil as are the larger shells.

The holotype is from Sandy Ridge (Locality No. 4). The Ripley is exposed here in a low cut on the Montgomery-Greenville highway just opposite the Sandy Ridge negro school, about 8½ miles north of Ft. Deposit, Lowndes County, Alabama. This outcrop is a calcareous clay containing sand, glauconite, fish remains, and an abundance of mega-fossils, including *Exogyra costata* (Say). It bears a rich assemblage of foraminifera.

Family ANOMALINIDAE

Genus ANOMALINA d'Orbigny, 1826

Anomalina harperi n. sp.

Plate XXIX, figs. 1, 2.

Test almost equally biconvex, the ventral side somewhat conical, the dorsal side slightly flattened at the center; periphery subacute, smooth in early stages, later becoming lobate; chambers numerous, 9 in the last coil, increasing in size very gradually, early chambers concealed on the dorsal side by a spiral of clear shell material occupying the umbilical area, chambers involute on the ventral side, a small umbo at the center of the coil; sutures slightly limbate on the dorsal side, smooth on the ventral side, curving slightly from the center of both faces to the periphery; wall coarsely punctate; aperture an arched opening at the base of the chambers on the periphery of the penultimate coil, extending a short distance onto the dorsal side under the margin of the chambers. Diameter of the holotype, 0.6 mm.

Anomalina harperi occurs frequently in the Ripley of the

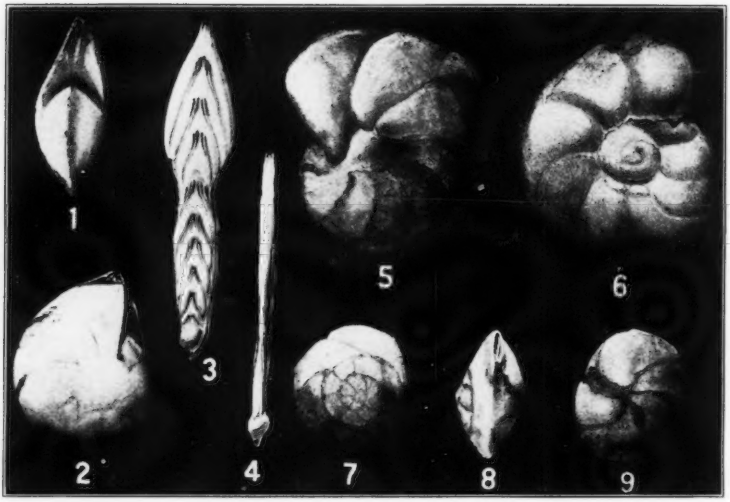
1 Plummer, Helen Jeanne, Personal communication. Sept. 22, 1931.

Alabama River section. The species is named for Dr. Roland M. Harper, of the Alabama Museum of Natural History.

The holotype is from the exposure at the mouth of Boguechitto Creek (Locality No. 106). A low bluff occurs at the point where Boguechitto Creek joins the Alabama River, and a fault brings the Selma chalk up against the lower Ripley beds. The displacement appears to be about 25 feet. The Ripley strata are typical calcareous ledges, and contain numerous mega-fossils. The micro-fauna from this horizon is exceedingly rich and well developed. The upper part of the chalk exposed at this locality contains *Exogyra costata* and *E. ponderosa*. It has a great many foraminifera, but the fauna does not appear to be as rich as that of the immediately overlying Ripley beds.

PRINCETON UNIVERSITY.

PLATE XXIX.



FIGURES

1, 2. *Robulus alexanderi* n. sp., x 40
Holotype from Barton's Bluff, Locality No. 53.
1. Peripheral view, illustrating character of aperture.
2. Lateral view, showing truncate apertural face.

3, 4. *Frondicularia berryi* n. sp., x 18
Holotype from Barton's Bluff, Locality No. 53.
3. Side view showing marked constriction near the middle of the test.
Marginal view, illustrating compression of test.

5, 6. *Anomalina harperi* n. sp., x 60
Holotype from exposure at the mouth of Boguechitto Creek, Locality No. 106.
5. Ventral view, showing umbo.
6. Dorsal side, illustrating partially evolute character of test and peripheral position of aperture.

7. 9. *Pulvinulinella ripleyensis* n. sp., x 135
Holotype from Sandy Ridge, Locality No. 4.
7. Dorsal view, showing early coils and oblique transverse sutures.
8. Peripheral aspect, illustrating biconvexity of test and character of aperture.
9. Ventral view, showing curvature of sutures.

CRIBRATINA, A NEW GENUS OF FORAMINIFERA FROM THE COMANCHEAN OF TEXAS

C. H. SAMPLE

Phylum PROTOZOA

Order FORAMINIFERA d'Orbigny, 1826

Family TEXTULARIIDAE d'Orbigny, 1846

Genus **Cribratina** Sample, n. gen.

Genotype *Nodosaria texana* Conrad, T. A., in W. H. Emory, Report of the United States and Mexican Boundary Survey, vol. 1, pt. II, p. 159, pl. XIV, figs. 4a-c, 1857. (Cretaceous, between El Paso and Frontera.)

Description. — Test free, typically nodosarian in shape; chambers numerous, overlapping; proloculum bulbous; sutures depressed; wall simple, composed of medium to fine arenaceous material, cement calcareous or ferruginous; aperture terminal, cribrate, composed of numerous irregularly occurring subangular openings within an oval area; size, large, up to 10 mm.

Range. — Comanchean of Texas.

Cribratina texana (Conrad)

Plate XXX, Figs. 1a, b, 2a, b, 3, 4.

Nodosaria texana Conrad, T. A., in W. H. Emory, Rept. of U. S. and Mex. Boundary Surv., vol. 1, pt. II, p. 159, pl. XIV, figs. 4a-c, 1857, (Cretaceous, between El Paso and Frontera); Bose, E., Monografia geol. y paleontol. del Cerro de Muleros, Inst. Geol. Mex., Bol. XXV, p. 177, pl. XXXV, figs. 4-6, 9, pl. XLV, fig. 3, 1910, (Cerro de Muleros, subdivision 5, 6, horizon with *Schloenbachia trinodosa*, lower Cenomanian); Christner, D. D. and Wheeler, O. C., Univ. Texas Bull. 1819, pl. VIII, 1918, (Cretaceous, Terrell County, Texas); Adkins, W. S. and Winton, W. M., Paleontolog. correl. of the Fredericksburg and Washita formations in North Texas, Univ. of Texas Bull. 1945, p. 76, pl. XXI, 1920, (upper third of Weno marl (abund.) to Pawpaw clay (rare), associated with *Exogyra arietina* in Del Rio clay); Adkins, W. S., The Weno and Pawpaw fms. of the Texas Comanchean, Univ. of

Texas Bull. 1856, p. 145, pl. XI, fig. 2, 1920; Winton, W. M., The Geol. of Denton Co., Univ. of Texas Bull. 2544, pl. XV, fig. 4, 1925, (upper Weno); Carsey, D. O., Foram. of the Cretaceous of Central Texas, Univ. of Texas Bull. 2612, p. 36, pl. 6, fig. 10, 1926, (Del Rio of Central Texas); Adkins, W. S., Univ. of Texas Bull. 2838, p. 59, 1928. *Haplostiche texana* (Conrad) Plummer, Helen Jeanne, Some Cretaceous Foraminifera in Texas, Univ. of Texas Bull. 3101, 1931, p. 124, pl. XV, fig. 1.

Description. — Test free, nodosarian in shape; chambers numerous, overlapping; apertural chamber larger and better rounded in microspheric than in megaspheric form; proloculum small in microspheric form, large in megaspheric form; sutures depressed; wall medium to finely arenaceous, cement calcareous or ferruginous; aperture terminal, cribrate, composed of numerous subangular openings within an oval area, better developed in microspheric form; size, up to 10 mm.

Range. — Comanchean of Texas.

Discussion. — The writer first became acquainted with the species under consideration in 1928. At that time it was generally conceded that the classification of this species with *Nodosaria* was a misfit. Various other genera have been tried, but none seem to be entirely appropriate. Prior to the present time the genus *Cribrogenerina* has been more appropriate for this species than any other genus described. *Cribrogenerina* may be biserial in its initial stage and has an aperture of an entirely different type from that of *Cribratina*. The initial stage in *Cribratina* is not biserial; its aperture shows no definite shape or arrangement; and the openings of the aperture are subangular in shape.

In so far as the literature at hand shows, the initial stages in this form have never been observed before. Mrs. Helen Jeanne Plummer first recognized the microspheric and megaspheric forms in this species. The study here confirms this discovery. Megaspheric forms are more numerous and better preserved than the microspheric forms.

The material from which these descriptions were taken comes from a low hill to the east of the junction of the

Marathon-Terlingua road with the Alpine road, Brewster County, Texas.

The writer wishes to acknowledge his gratitude to Dr. H. N. Coryell of Columbia University for his helpful suggestions and criticisms in the writing of this paper, and to Dr. F. L. Whitney of the University of Texas for his advice concerning the best locality from which to collect.

PLATE XXX.

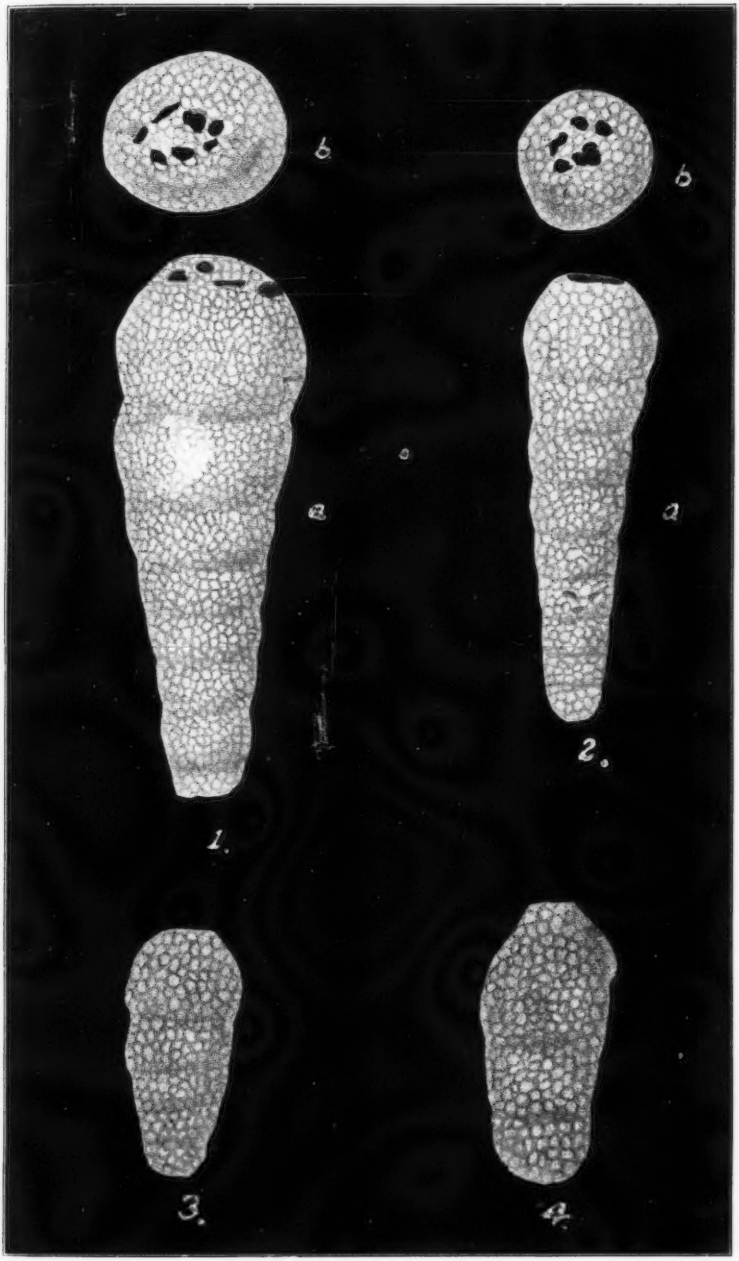
Fig. 1. *a*, incomplete test of microspheric form of *Cribratina texana* (Conrad); *b*, view showing aperture of same specimen. x 12.

Fig. 2. *a*, complete test of megaspheric form of *C. texana* (Conrad); *b*, view showing aperture of same specimen. x 11.

Fig. 3. Young microspheric form of *C. texana* (Conrad). x 20.

Fig. 4. Young megaspheric form of *C. texana* (Conrad). x 20.

PLATE XXX.



CONODONTS IN RELATION TO PETROLEUM

FRANK H. GUNNELL

Conodonts are minute teeth which the writer places with the Cyclostomata, the reason for this classification being that in the Cretaceous strata there occurs an undescribed genus intermediate in shape between a tooth of the modern *Petromyzon* (Cyclostomata) and certain Pennsylvanian conodonts.

The cyclostomes migrate to continental waters for spawning purposes. Their strenuous activities during spawning cause them to become weakened and death results.[1] The carcasses are deposited in lagoonal and other types of near shore deposits. These types of sediments form the geologic environments of conodonts.[2] Since evidence at hand indicates that conodonts are ancestral cyclostomes, the abundance of these minute teeth in the sediments of the Paleozoic and Mesozoic eras suggests that large numbers of cyclostomes have existed in the geologic past.

The teeth are the only hard parts of the cyclostome, and compose less than one percent of the creatures' total weight. As each individual contains about 135 teeth, by counting the teeth in a given sample an estimate could be obtained of the abundance of pre-existing cyclostomes in the locality.

In view of the general concept that petroleum is of organic origin the large amount of fat in these conodont-bearing animals, (if indeed they are related to the modern cyclostomes and of similar composition), would, because of their great number as indicated by the abundance of teeth, be a significant contribution of material suitable for conversion into petroleum.[3] It is significant that some of the strata most abundant in conodonts are the supposed source beds of petroleum—such

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[1] D. S. Jordan, Guide to the Study of Fishes. Vol. I, pp. 486-506.

[2] F. H. Gunnell, Conodonts from the Fort Scott Limestone of Missouri, Jour. of Pal., Vol. 5, No. 3, p. 244, 1931.

[3] Fishes as a source of petroleum have been discussed by previous workers.

as the Cherokee shale of the Pennsylvanian, the Chattanooga shale of the Mississippian, and the basal sandstone of the Chattanooga.

The wide distribution of conodonts in petroleum bearing horizons began with the Ordovician, which is the oldest period from which they have been described. Other horizons in which conodonts and petroleum occur abundantly are the upper Devonian, lower Mississippian and the Pennsylvanian.

The occurrence of these fossils in Cenozoic strata has not been reported. Their relationship to cyclostomes, however, indicates that they do occur in the Cenozoic.

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NEW ASTERS FROM ILLINOIS

HERMANN C. BENKE

I. Quite a number of years ago some plants of the genus *Aster* were found by me in Wisconsin which would not well key down to *A. furcatus*, *A. leptocaulis* nor any related species or variety. It is recalled how puzzled were the workers to whom it was shown so it was buried in the "undetermined" collection. Years later this aster was again found, this time in the region of Crystal Lake, Illinois, not as a few isolated plants, but in considerable colonies in the woodlands about the lake. It was at once recognized as the plant which caused so much trouble before. With plenty of material now at hand, the study of this aster could be taken up once more. It has the aspect of *Aster leptocaulis*, but belongs rather with *A. furcatus*, though the well-known leaf-laciniations, so familiar to workers with this species are missing.[1] Desiring to be conservative it is proposed to separate this plant as a variety:

Aster furcatus Burgess var. **elaciniatus** var. nov.

Varietati typicae conformis sed paullo altior; foliis prope basin nunquam laciniatis.

Like the species but rather taller; laciniations or auriculate appendages none on any of the leaves, differentiating it from the species. From *A. leptocaulis* Burgess it differs in hairiness of the stem (especially upward) and leaves, the latter wider and more pubescent; inflorescence longer-branched—rather as in *A. furcatus*.

ILLINOIS: Crystal Lake, McHenry County, Sept. 2, 1928. *H. C. Benke*, No. 4836 (Type in Field Museum).

II. About a mile to the north of McHenry lies the beauti-

[1] See Burgess, Mem. Torr. Bot. Club, Vol. 13, p. 246, 1913—". . . with broad laciniate-winged bases."

Also, Britton and Brown Illus. Flora, Vol. III., p. 410, 1913—". . . the upper sessile, with broad laciniate-winged bases."

ful little McCullams Lake. Near it passes the C. & N. W. Railroad, but there is a meadow of considerable extent between track and lake. Along the railroad track grow colonies of the pretty *Aster laevis* while the lake shore is crowded with other species, *A. paniculatus* for the greater part—with its somewhat obscure relative *A. Tradescanti.* Some of the colonies in the meadow show such convincing intermediate characters between the two species in proximity that hybridism may be suspected with good reasons, though great caution should herein be observed:

Aster laevis L. × **Aster paniculatus** Lam.
~~**Aster L. × Aster paniculatus Lam.**~~

Folia eis A. laevis similia sed minus amplexicaulia; capitula eis A. laevis fere aequilata sed paullo numerosiora, ligulis purpureo-caeruleis; involucri bracteae eis A. paniculati conformes; pappus albus.

Intermediate in size and branching habit between the two species named; leaves as in average specimens of *A. laevis,* less clasping; flower heads nearly as large as in *A. laevis,* but little more numerous with rays purple-blue; involucral bracts as in *A. paniculatus;* pappus white; differing from *A. lucidulus* (Gray) Wiegand strikingly by the bracts, etc.; plant nearly glabrous.

ILLINOIS: McHenry, McHenry County, Sept. 30, 1931. *H. C. Benke,* No. 5280 (Type in Field Museum).

III. In 1927, there was found by me in down-state Illinois a variety or form of *Aster ericoides* L. (*A. multiflorus* Ait.)[2] the main distinguishing character of which was the beautiful caerulean blue of its rays.[3] This variety was again found by me on Sept. 23, 1929, just in the edge of Schiller Park,[4] southward from DesPlaines, Illinois. Not far away and on the same date was discovered a similar aster, yet more rare and beautiful:

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[2] See Blake, RHODORA 32: pp. 136-140, 1930.

[3] See Benke, RHODORA 30: p. 78, 1928, and Blake, RHODORA 32: pp. 138-139, 1930.

[4] See Benke, RHODORA 34: p. 8, 1932.

Aster ericoides L. forma **Gramsii** f. nov.

Formae typicae similis, ligulis pulchre roseo-rubris; foliis acutissimis interdum mucronatis; pappo pallide vel intense fulvo.

With the species, but rays a beautiful rose-red; leaves very acute, even spine-tipped; pappus pale to deep tawny.

ILLINOIS: Schiller Park, Cook County, Sept. 23, 1929. *H. C. Benke*, No. 4948 (Type in Field Museum).

Mr. Wm. F. C. Grams, now living in retirement at Des-Plaines, Illinois, is an enthusiastic friend of the wild flowers. For almost half a century he has accompanied me on numerous field trips. This charming plant was found at no great distance from his home and it is with pleasure that it is named for him.

CHICAGO, ILLINOIS.

BOOK REVIEWS

AN INTRODUCTION TO GEOLOGY, by William Berryman Scott. Third Edition. New York: The Macmillan Company, 1932. 2 volumes: xiii + 604 pp., $3.50; vii + 485 pp., $3.00.

Professor Scott's *Introduction to Geology* has for years been known as a successful textbook, suited both to the beginning student and the general reader desirous of obtaining something more than a "popular science" view of earth forces and history. In its new form, it appeals to students more mature in purpose and knowledge, yet retains its value as a modern and thoroughly readable account of the one natural science in which really popular books are almost negligible.

Volume I of this rewritten edition deals with those manifold phases of geologic science most conveniently grouped as physical geology. A twenty-page introductory chapter outlines these divisions, summarizes the present condition of the earth, and introduces the reader to such subjects as isostasy and the Taylor-Wegener hypothesis of continental drift. For a beginner, such haste may be confusing; yet the advanced student will find it a useful summary of material studied but partly forgotten. As for the general reader,—he is almost sure to be more familiar with moving continents than with processes of erosion, and so will find himself at no disadvantage.

Beyond this introductory chapter, the treatment is genetic rather than topical. The discussion of rock-forming minerals leads to igneous rocks and rock masses, and thence through vulcanism, volcanoes and thermal springs to Chapter IX, on diastrophism and earthquakes. Chapters X - XVII are devoted to sediments, sedimentation and factors related thereto. The classification of sedimentary rocks is adequate though not novel; in cases such as that of dolomite, attention is called to the inadequacy of present knowledge. The atmosphere is stressed as a maker of materials for sedimentation rather than merely as a destroyer of rocks, and a similar motif dominates the chapters on water. For the sea, however, it has been necessary to provide one chapter on destruction and one on reconstruction, the latter giving special attenion to the work of marine organisms and the condition necessary for their effective action. A brief section on diagenesis calls attention to the rapidity with which rocks may be compacted or indurated—a matter of importance in the study of ripples, cracks and other physical records of sedimentation.

Chapters XVII - XXII are devoted to structural geology, metamorphism and metamorphic rocks. The relationship of unconformities and overlaps to diastrophic movement is well shown, as is the influence of

structural features upon topography. The remaining two chapters deal with mineral deposits and physiography—an allotment of space less unfair than it seems, since physiographic processes have appeared often on preceding pages. Throughout the volume, novel and well selected photographs add to the text, though some of them are not well printed.

Volume II, Historical Geology, is less novel in plan than is Volume I, since its chapters necessarily are chronologic. There is little about the origin of the earth: Professor Scott believes that geology properly is derived from study of rocks. Discussion of the Archaean is impartial and cautious, with direct quotation from authorities, while that of the Proterozoic (to which Professor Scott would restore the name Algonkian) is brief. The Ozarkian does not appear as a system; the name Ordovician is retained; Carboniferous replaces the later Mississippian and Pennsylvanian, though the Permian stands as a distinct period. Current trends also are followed in restoration of the Tertiary period, though it is divided into Eogene and Neogene sections. Discussion of the Pleistocene is as modern as one can ask, including both the published statements of Kay and Leighton, and manuscript opinions of the latter worker.

As in the preceding editions, much attention is given to fossils. Plates illustrating invertebrates, and most of those showing vertebrates, were drawn by Bruce Horsfall; the second of these groups is dealt with in somewhat greater detail than their taxonomic importance seems to warrant. Plants are reviewed more thoroughly than is usual, the chief source of information and reference being Seward's *Plant Life through the Ages*. Paleogeographic maps are generalized and omit a few important outcrops; one gathers from the text that Professor Scott places less confidence in them than does Professor Schuchert. Brief bibliographies with each chapter serve to guide student reading as well as to indicate authorities for statements made, while concise summaries of outcrops in continents other than North America give balance to these chapters and greatly increase their value as convenient references.

No attempt need be made to point out the minor errors that inevitably appear in a book so comprehensive, or to note statements on which there is difference of expert opinion. That is a task for cooperating specialists, or for teachers who find emendation essential. After all, the significant features of this *Introduction* are its balance, its modernity and its fairness. It was Professor Salisbury who remarked that when "knowledge dies, we embalm it in textbooks and bury it in the minds of Freshmen." Dr. Scott's book contains very little of artificially preserved misinformation, and a surprising amount of knowledge that still is in the fluctuating stages of youth. More than any other textbook that has come to hand, therefore, it presents geology as a living, growing science, in which new ideas find ready place and new workers incentives for production.—CARROLL LANE FENTON.

MAMMALS OF NEW MEXICO, NORTH AMERICAN FAUNA

No. 53, by Vernon Bailey. Government Printing Office, Washington, D. C., 1931. Price $1.00.

Mammals of New Mexico, North American Fauna No. 53, by Vernon Bailey, Senior Biologist, Division of Biological Investigations, Bureau of Biological Survey, published December, 1931, is a noteworthy successor to the preceding 50 numbers of the North American Fauna. (Nos. 6 and 9 were never issued.) It represents work begun by the author in 1889, and continued by him over a period of many years, assisted by many members of the United States Biological Survey as well as by Mrs. Florence Merriam Bailey, whose Birds of New Mexico appeared in 1928. In addition to the collections and observations made by members of the Biological Survey, the report is also based upon the earliest publications and collections from the time of the Spanish explorers and early army expeditions down to the present day. This is the sixth North American Fauna published by Vernon Bailey, veteran naturalist and collector. No. 35, by him, is entitled the Life Zones and Crop Zones of New Mexico.

The present work is the third largest of the Faunas to be printed, comprising 412 pages, 22 plates and 58 text figures. The text figures are maps of New Mexico showing the distribution and the places of obtaining specimens of most of the species mentioned in the text. The plates for the most part are taken from photographs of living specimens of New Mexican species of mammals. They add much to the attractiveness of the book. The maps are particularly good in that they show at a glance the range of the various forms throughout the state.

Two hundred fourteen species and sub-species distributed in 25 families are described. Ample notes are given on the distribution, habitat, habits and economic status of most of the forms. No one is better qualified to write of the habits than the author who has had extensive field experience, not only in New Mexico but in many other states. The original place of publication of each form is stated as well as the type and its place of collection.

The reviewer is pleased to see that English names are given for every species. Scientific names, even though in many cases shorter than the English names, seem to be a stumbling block to the uninitiated. These common names should prove of considerable assistance to the museum worker who has to arrange and label exhibitions. In addition to the English name, the Indian names of many of the animals are cited.

A bibliography of 85 titles concludes the work, seven of them by the author himself.

The reviewer has nothing but praise for the book, which will prove an invaluable guide to the natural history of the mammals of New Mexico, as well as to those species having ranges far beyond the state.

—MARCUS WARD LYON, JR., South Bend, Indiana.

THE LIFE OF THE BUTTERFLY, by Friedrich Schnack. Houghton, Mifflin Co., 1932. 278 pp. $2.50.

His publishers herald Mr. Schnack as "an entomologist with a passion for his subject," who describes butterflies with "loving care" in lyric language which vies with Hudson's.

It seems, however, that his passion and lyricism have routed science. How else can one explain the assertion that sphinx moths are "highly evolved species of the butterfly race"? Even if we blame the poor translation, such a blunder must derive from the author—as also must the poetic account of "that pre-time before the time of man, when mountains bounded upon the shifting earth like waves upon the ocean." This information will enlighten geologists, while evolutionists should draw inspiration from the theory that butterflies with azure wings "are descended from forefathers that fell from heaven," while those marked with spots of red carry "memorials to those wan springs and summers when every red bloom vanished."

The book, in short, is arrant nonsense compounded with just enough entomology to impress sentimental nature lovers who go about adoring animals. For such stuff there always is a market, but one hopes that grossly deceptive pretenses will not carry this volume into school or museum libraries, there to take shelf space from better volumes.—C. L. F.

KAMONGO, by Homer W. Smith. Viking Press, 1932. 167 pp. $2.00.

This book, by a well-known physiologist, is neither written nor published as a scientific effort. Primarily, it is a philosophic discussion which presents in a somewhat novel form a modern version of Huxley's agnosticism, with a fairly effective rebuttal. Yet it hinges on an expedition in search of African lungfishes, whose surprising habit of drowning when netted caused most of Dr. Smith's troubles. His first seventy-five pages contain many significant facts not mentioned in standard biologies, scattered through excellently written narrative. The zoologist is bound to regret that still more pages are not given to the lungfish, about which Dr. Smith plainly knows much, and of which far too little has been written.—C. L. F.

COMMON PESTS, by Rennie W. Doane. Charles C. Thomas, 1931. vii + 397 pp. $4.00.

A compendium of condensed information on animal pests branching from flatworms to mammals, this volume is intended to summarize and in a measure replace the cumbrous files of official bulletins in which most accounts of pests have been published. Its purpose, therefore, is purely practical,—and in the main seems to have been achieved. Comparative freedom from technicality and abundant half-tone illustrations add to the book's utility, while Professor Doane's reputation is ample assurance of accuracy.—C. L. F.

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